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Banana Culture in Western Australia.

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IT is intended that this article should cover the experience gained since the inception of the Gascoyne industry without, in any way, detracting from the value and helpfulness that must have been gained by the original settlers at Carnarvon from previous communications. At the same time, it is hoped that the following notes will assist new growers to avoid numerous pitfalls and also help present growers to increase the yield of fruit produced per acre per annum at reduced production costs.

Gascoyne River in flood.

The industry as a whole has enjoyed great prosperity during the war years, mainly through lack of competition on a bare market, and during this period of high prices, many of the finer points of production and especially preparation for market have been lost sight of. With the return to peace-time market conditions in sight, Gascoyne settlers must realise that in the not distant future competition on the metropolitan markets will have to be faced both from their old competitor Java and from the Eastern States. With a very substantial increase in production inevitable in New South Wales and Queensland, and the possibility of over-production and uneconomic prices, the industry in those States is searching for ways and means of reducing production costs, improving transport and ripening methods and the expansion of their markets. Already it has been seen what effect good Eastern States bananas can have upon our lower grade lines and that, providing the W.A. product is good, it can withstand serious competition. It is quite obvious therefore, that prices realised over the past few years cannot be maintained and the W.A. industry like the Eastern States, must strive for better yields at more economic cost and the forwarding to the consumer only the best in the best condition. While the individual grower is responsible to himself alone for the production of good quality fruit and while it is not suggested that he should extend his individual activities beyond the production point, nevertheless it is the responsibility of banana growers collectively, to see that improved transport, ripening and marketing facilities are attained wherever possible. Remember the consumer is your master who demands a good quality product, i.e., a banana with appearance, flavour and keeping qualities. This can only be achieved through good farming, good transport and the highest standard of ripening methods.

Soil.

While there are approximately 4,000 acres within the settlement area, not all this land is suitable for banana culture. Generally speaking, the best land is in close proximity to the banks of the river, this being of brown micaceous loamy sands, and sandy loam layers, generally calcareous in the subsoil.

Owing to the low average rainfall (9 inches) the nitrogen accumulation is low and Dr. Teakle's work ("Terraced Soils of the Gascoyne River at Carnarvon") classes the soil as being poor to medium in nitrogen and organic matter, medium to normal with respect to phosphates and good to rich in potash. The fact that the soils lack nitrogen indicates very strongly the desirablity of building up the organic matter in the land as soon as it is cleared, and this can be achieved by the growing of green crops and the turning in of liberal quantities of acacia leaves (hundreds of tons of which are available to the energetic grower), and sheep manure.

Behind this tract of land on some locations are soils of a heavier and stiffer nature which, while in the virgin state, are too heavy for successful banana culture. If given correct treatment there is little reason why these areas should not be brought under production.

Vegetation.

The native vegetation on these soils comprises mostly thickets of wattles (acacia spp) interspersed with salt bushes (atriplex spp and Rhagodia spp), stunted gums (Eucalyptus rostrata) and seasonal grasses and herbage plants. (Fig. 1.)

Fig. 1.—Typical banana land in its virgin state.

Water.

The annual rainfall is of such a scattered nature as not to be relied upon, and irrigation practices are adopted throughout the whole of the year. Each settler possesses his own irrigation unit and, wherever possible, this is installed on the riverbank and the water drawn from the river sands which are approximately 20 feet deep. In many instances, growers have been successful in locating an additional water supply after boring through the river clay bed to a depth of 30 to 40 feet, but the quality of these waters, in some instances, varies with the seasons. This underground supply rises to the level of the water in the river sands. The quality of the river water is good, the principal salt is sodium chloride (12 grains per gallon) and a considerable proportion of calcium. The average irrigation unit consists of a 10 h.p. Diesel engine, 2½ inch to 3 inch centrifugal pump, (Fig. 2); 3 inch suction and delivery pipe line and 3 foot 6 inch diameter cement cylinder or well—delivering 8,000 to 10,000 gallons per hour. The engine and pump unit is the most valuable asset the grower possesses for if this is not operating satisfactorily his livelihood is in jeopardy, therefore this outfit should be properly housed, regularly serviced and thoroughly overhauled each winter. Where it is necessary for settlers to obtain water supplies other than from the river sands, it is advisable before erecting pumping equipment on the site, to submit samples to the local office of the Department of Agriculture for analyses.

This procedure is recommended at all times if a grower is in doubt as to the salinity of his irrigation waters.

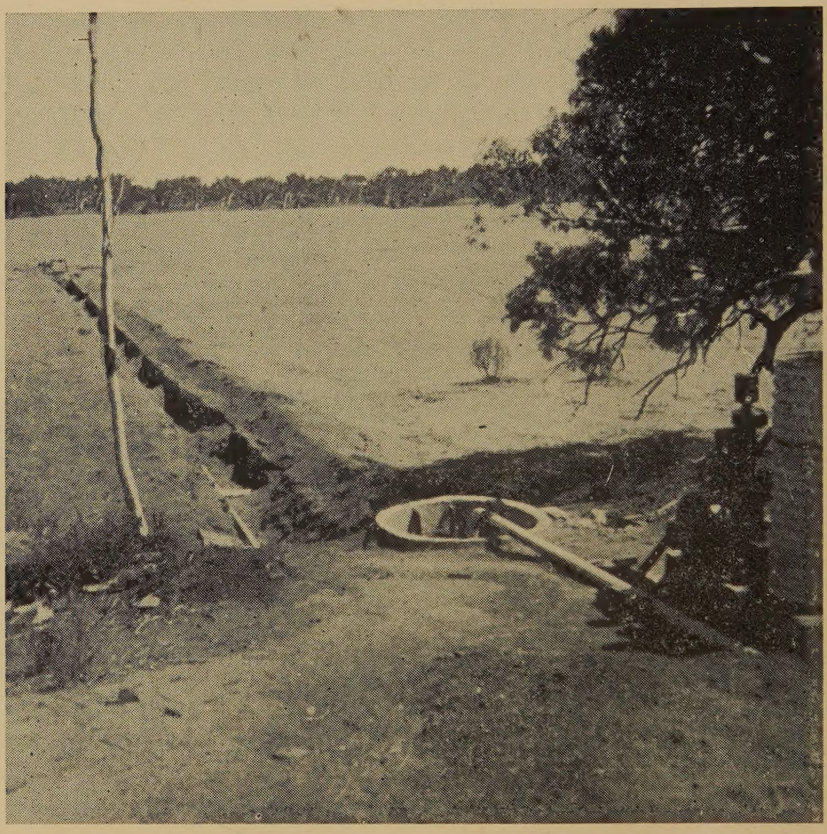


Fig. 2A.—View of irrigation unit showing from right to left: The engine, delivery line, pump well, suction line and, upper left, the 3ft. 6in. diameter cement cylinder in river sands.

Fig. 2B.—First stage of well under construction in bed of river. The sands are

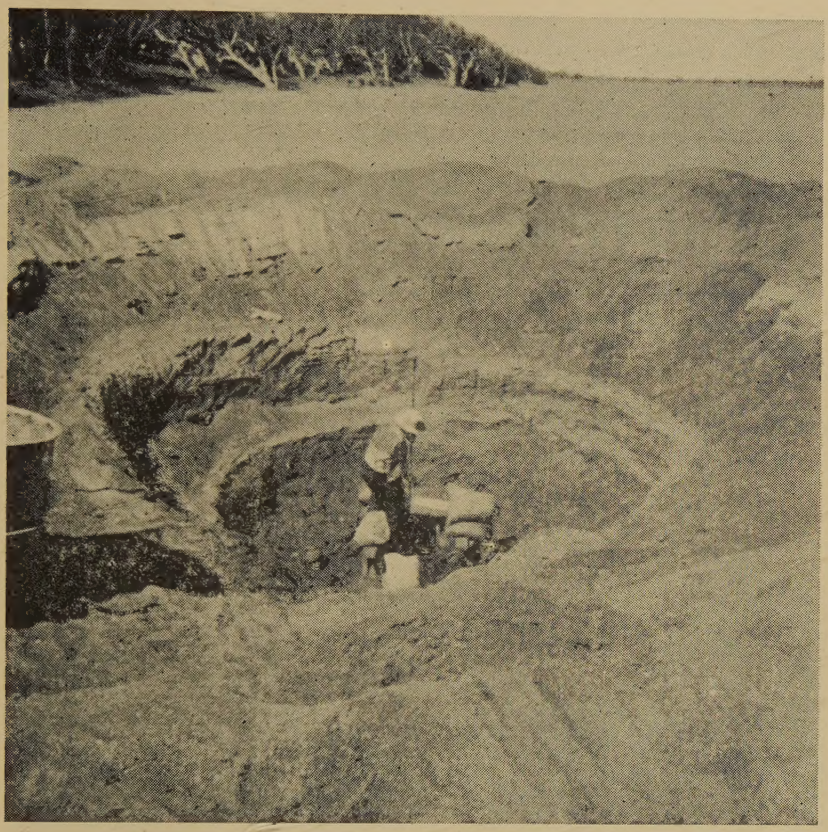


Fig. 2C.—Second stage. Using a sand pump to lower cylinder down to water in river sands.

Fig 3.—Typical Gascoyne banana land after ploughing.

Preparation of Land.

For best results, the greater part of land preparation should be carried out one year prior to planting time. That is, the land should be cleared (all major roots grubbed), graded and ploughed as deeply as possible. (Figs. 3 and 4.) Severe grading should be avoided and it is better to make the plant rows conform to the natural contour of the land. Plant rows should be struck out and cover crops planted. Suitable summer cover crops are Poona Pea, Jerusalem Pea, (Rice bean), Pigeon Pea, Crotalaria, Mauritius Bean, Cow Pea or Soya Bean, while New Zealand and Blue Lupins or Gray Field Peas produce a heavy tonnage of green matter during the winter months. These crops should be ploughed in as soon as maximum growth (the flowering stage) has been reached. Following the ploughing in of a leguminous crop it is advantageous to grow a crop of barley, oats, or other straw crop.

Fig. 4.—Grading the land with power grader.

Windbreaks.

As Carnarvon is notoriously windy (there are claims that it is windiest location in the southern hemisphere) windbreaks are essential for contracting the almost continuous south-westerly winds, and the occasional hot dry easterlies in the summer. These breaks should be erected or planted in sufficient time to insure their establishment for maximum efficiency by protecting the young banana plants as soon as they commence to flag.

Many and varied have been the types of windbreaks tested around plantations, but little attention has been paid to the establishment of permanent wind protection.

For efficiency a windbreak cannot be too high, but it can lose its effectiveness if too dense. A dense windbreak affords protection for plant life in close proximity for it causes wind to be deflected upwards, but the pressure of air current behind this deflected air stream forces it onwards and downwards with the result that plant life further away from the break appears to suffer more severely than if the direct wind force was passing along its natural course.

Seven year Bean, or Poor Man's Bean, has been used a great deal in the past, but was discarded owing to nematode infestation, and its competitive root system with the banana. North Coast or Wooramel Creeper (*Momordica balsamina*) (Fig. 5) used in the same manner as the seven year Bean has proven less detrimental, but is a harbour for rats, orange piercing moth and other pests. Such types of breaks are temporary and costly when posts, wires, brush and labour costs are considered. The most popular break at present is the Plantain (*Musa paradisiaca*) (Fig. 6) having in its favour speed of growth, height, similarity of growth to the crop it is protecting, while growing dense it is not too dense and appears to mince the oncoming wind. During dead calm summer days air currents are able to pass to and fro.

Fig. 5.—Windbreak of Wooramel Creeper.

The Plaintain also has a value in that it produces a crop of some commercial value. Despite the advantages of this plant it is, after all, of a temporary nature and more attention should be paid to permanent breaks. The River Gum, Mesquite, Carob Bean, Pines and Mango are worthy of consideration. A break of dense topped trees intermixed with taller topped forms, makes an irregular and more satisfactory shelter than one of uniformly tall dense trees.

Where Plantains are used for a break it is recommended that the suckers be planted stagger fashion along the row at a distance of 4 to 5 feet apart. Owing to their height, they should be planted about 12-15 feet from the first row of bananas.

Fig. 6.—Windbreak of Plantains.

Fig. 7A.—Spillpool. This is a 5ft. deep and 3ft. 6in. diameter cement cylinder with the water entering from the delivery line near the [illegible]

Layout of Plantation.

The layout of the plantation should be so planned to achieve compactness of first and consecutive plantings, to enable quick, frequent, and economic irrigations. To achieve this impervious drains are very desirable from the spill-pool (Fig. 7A) to the gates or stops at the head of the banana rows; each subsidiary drain should be so built to enable water to be delivered to banana rows from each side of the drain. (Fig. 7C.)

Fig. 7B.—Main drain and Plaintain windbreak.

Care should be taken when erecting the cement drains to insure sufficient height of the gate or inlet above the banana rows, for the banana basin or irrigation row gradually silts up, and in a few years difficulty will be experienced in pushing the water flow down the banana rows. Careful attention should also be given to the spill-way at the inlets to the banana rows so that scouring of the soil does not take place that will weaken the main drain foundations. The spill-way from the drain to the banana row should be so constructed that the water upon leaving the inlet will immediately drop to the level of the surface soil in the banana row. Make sure the stops or outlets are large enough to permit the easy flow of the maximum amount of water likely to be ever available.

The banana rows should be short in length, 3 to 4 chains being quite sufficient. Short rows eliminate a considerable amount of grading, enable quick and frequent waterings, this being not only of advantage to bananas, but is of considerable value in the event of prolonged heat waves, mechanical breakdowns in the irrigation unit, shortage of water supplies. The value of short rows is also appreciated when carrying out bunches at harvesting time, when manuring, or carrying out most cultural operations.

It is advantageous to have a slight grade to the banana row in preference to making the rows perfectly level. Difficulty is likely to be experienced with level rows when irrigating after the first year, by trash lying on the soil surface retarding the flow of water down the banana rows. All grading operations should be completed before planting out and it is much better to make a late season planting in preference to attempting to complete grading after planting.

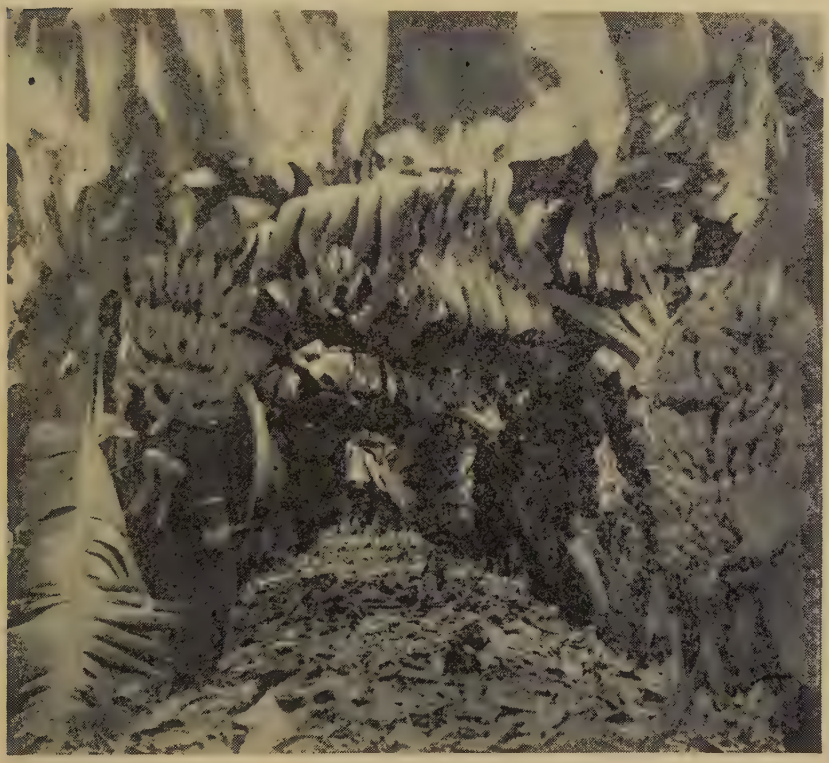
Fig. 7C.—Subsidiary irrigation drain with spillways to banana rows. Note drain elevated above banana rows but bottom of spillways level with banana rows.

Planting Distance.

Included with the layout of drains and length of rows, the system of plant rows, distance between rows and plants should be given full consideration. Distance apart of rows and plants will always raise a controversy, while wide rows and plants in rows, say 12 feet by 12 feet, have many advantages, this system

is largely defeated under Gascoyne conditions by exposure of plants to winds and heat. An ideal distance appears to be 10 feet by 10 feet (11 feet by 11 feet for tall varieties), thus enabling early protection from wind and heat, but possibly reducing the life of the plantation by a small degree. Under Gascoyne conditions it is advantageous to practise concentrated farming principles as much as possible, and close planting of crops will tend to increase humid conditions which are so desirable for the success of tropical crops. In order to arrive at the number of plants required to plant an acre of land the following method is adopted:—

Reduce one acre to sq. feet = 43,560 sq. feet: divide this by the square of the distance apart at which the suckers are to be planted.



Looking along rows of a well developed Cavendish plantation

Plant Rows.

Preparation of plant rows will depend upon equipment available to the individual settler. In the past, the camel and horse have eliminated much laborious hand labour, but with the advent of tractors and other power implements to the settlement, this work can be further facilitated and more economically carried out. Illustrations on pages 84, 90 and 102, depict some of the methods used by settlers and each has its advantages and disadvantages.

After the general ploughing, cross ploughing and levelling has been completed, the plant rows should be laid out. (Fig. 8.) Along the plant rows the plough should be travelled several times, setting the plough as deeply as possible. The rows should then be opened out with a double mouldboard (Fig. 8), or other such implement to a width of three to four feet, and the plough again travelled

up and down the newly made basis to as great a depth as possible. By this method it is possible to disturb the soil to a depth of two to three feet and will greatly eliminate the necessity of digging plant holes.

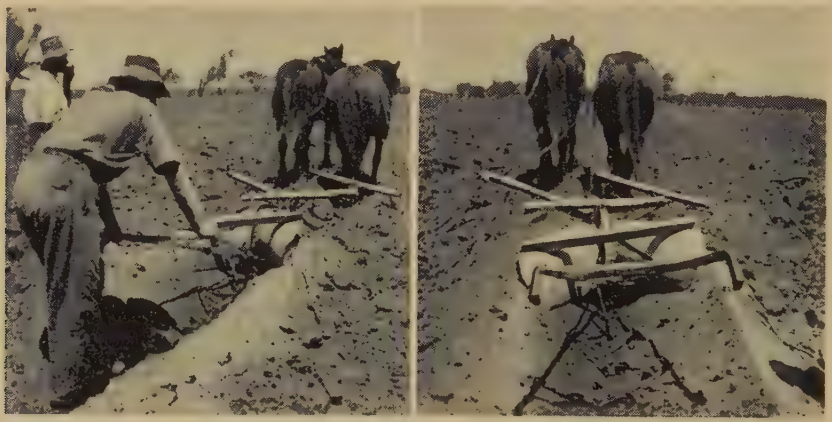


Fig. 8.—Opening plant row with double mouldboard plough.

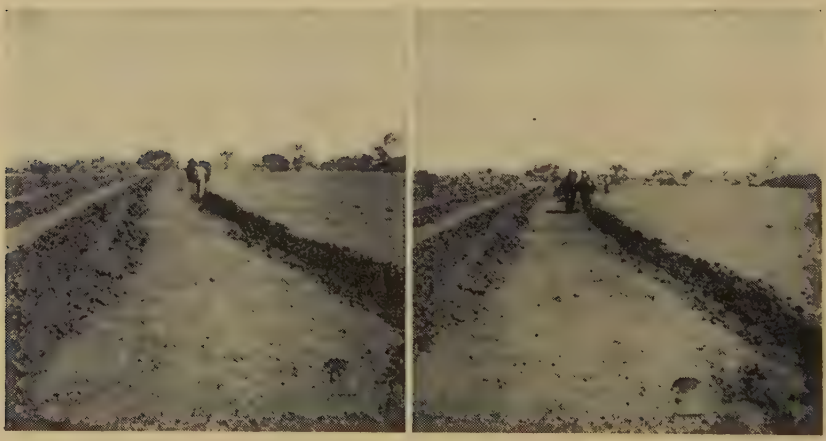


Fig. 8A.—Opening banana rows with mouldboard plough.

It is recommended that liberal supplies of acacia leaves or sheep manure be broadcast along the plant rows prior to making the final deep ploughing.

If mechanical means are not available for the laying out of plant rows it will be necessary for the grower to dig holes. These should be approximately two feet deep and three feet wide—the wider the better—the top 12 inches of soil should be kept aside and returned to the bottom of the hole in which should be incorporated one or two tins of acacia leaves. It is important to well mix the acacia leaves with the soil.

Tillage of the soil is one of the most important factors entering into the production of good bananas, and success depends to a considerable extent upon the thoroughness of preparation given the soil before planting. As previously stated, this preparation of the land should be carried out a year ahead of planting, and once the above work is complete, cover crops should be encouraged.

Planting.

Just prior to planting the land should be irrigated, the plant row or holes should be cultivated and if the land is carrying a cover crop, as much as possible should be turned into the ground.

Depth of planting will vary with the type of propagation material being used, but as a general rule the bottom of the plant should be about 15 to 20 inches below the surface of the trench basin or hole, this depending upon the type of propagation material used, and should be covered with eight to 12 inches of soil.

If the land has been properly prepared, it is only necessary to dig out sufficient soil to enable the plant to be placed in position. After planting gently press the soil around the plant, *but do not completely refill the hole with soil.* By leaving a good depression around the young plant, a small stream of water may be used during the early stages of the plant's growth, instead of having to flood the entire plant row.

Many growers apply about 1 lb. of blood and bone to the plant hole at planting time, but providing the previously suggested ideas of soil preparation, acacia leaves and green crops, have been adopted, it would be more economical to withhold this manure until the plant has made several months' growth.

Fig. 9.—Plant rows with young banana plants. These plant rows or basins are periodically widened, eventually to about 8 feet. See Fig. 14.

Early Irrigation.

It is advisable to refrain from irrigating the young plantation until vegetative growth has shown above the surface soil. This is particularly advisable where small suckers are being used as propagation material, owing to the risk of rotting through too moist a condition during the heat of the day. Even after germination has commenced, it is recommended that irrigation during the first few weeks should be avoided during the heat of the day.

Once the plant is well established the basin or trench can be gradually widened. (Fig. 14.) The soil removed in the widening of the rows is spread in the trench or basin thus raising the level of the plant row, and increasing the depth of the plant in the soil.

In the basin method, this widening can be done with the plough.

Planting butts.

PROPAGATION MATERIAL.

It is increasingly realised that to improve the standard of crops it is necessary to select from strong, robust, heavy and good quality producing stock. When selecting bananas for propagation not only the parentage but the progeny itself must be considered because of the all important part it plays in the ultimate success of the plantation, and with the heavy initial outlay for the grower in this State compared to other parts of the Commonwealth, it is necessary to procure the best planting material possible both to ensure early and profitable returns and enhance the disease-resisting qualities of the plantation. It will be agreed that the planting of inferior banana stock will result in the plantation producing low grade bunches and poor quality fruit, but many experienced growers do not realise the necessity for the observation of more exacting details when selecting propagation material and the early attention some types of plants require.

Suitable Material.

Various parts of the banana plant may be utilised for propagation purposes, such as suckers, corms, butts, bits or eyes. At the present time in this State suckers are practically the only planting material available, and it is intended that these notes should deal more especially with the selection of this particular type of planting material. Before doing so mention might be made of the usage of corms, butts and bits or eyes. The opportunity of obtaining these types of

planting material is likely to be scorned by the new or inexperienced grower as being unsuitable, but good types of butts or pieces may give as good results as suckers providing they are properly handled before and after planting.

Butts (see page 92, "Planting butts") are generally obtainable from old or well established plantations which have become unprofitable. There are two types of butts, viz., the one that is secured from a growing plant and the one that is taken from a plant that has produced a bunch. The former type is the more desirable as it usually produces a better first bunch. The usual custom when selling butts is to divide the butt into two or more pieces—the cutting into sections or pieces being so performed that each piece possesses one or more strong eyes. Butts may also be planted whole but it is advisable to destroy all but one or two of the strongest eyes. (The surplus eyes can be destroyed by gouging from the corm prior to planting.) Good butts prove excellent for use as refills within the established plantation, thriving better than any other propagation material for this purpose.

When planting pieces or bits the cut surface should be turned uppermost, and therefore the eye or uncut surface will be in the bottom of the hole. Pieces usually take a little longer to come into bearing than is the case with butts. The use of eyes or bits cannot be entirely recommended for the Gascoyne district as they are liable to dry out very quickly and may possibly decay under irrigation. After subdividing the corms it is well to permit the cut surfaces to dry out a little prior to planting.

In the selection of suckers the intending grower should observe the vegetative growth, the producing qualities and the freedom from disease of the plant within the plantation from which he intends securing his plants. It is conceded that if the plantation is healthy, vigorous and producing good quality fruit the progeny should reproduce on similar lines.

Generally speaking the average plantation is considered to be in its prime between the age of three to six years, but it is suggested that growers take this as a guide only, for some plantations of less mature age may more than favourably compare with plantations between the ages mentioned.

One-Year-Old Stools.

The selection of suckers from one-year-old plantations is much to be discouraged, not only because of the inferior quality planting material available (Figs. 12a and 13) but the damage that may be done to the parent plant bearing or about to throw its bunch. Suckers selected from year-old plants cannot be expected to compare with suckers from a three-year-old stool (Fig. 11), as the year-old plant must necessarily be producing offsprings of tender growth which are only good quality plants in the making. No doubt there are exceptions, but when the damage likely to occur to the parent by the removal of suitable planting material is considered the wise grower will realise that the saving in the cost of plants or the money gained by the sale of such suckers will not recompense him for the damage to the young parent and developing bunch. The sucker being tender is likely to give poor planting results should adverse weather conditions be experienced, but should the grower find it necessary to use such material in establishing his plantation he should arrange for the planting to be carried out as quickly as possible after the removal of the sucker from the parent plant Additional care should be taken during the removal of the sucker from the parent both from the viewpoint of the young parent and tender offshoot.

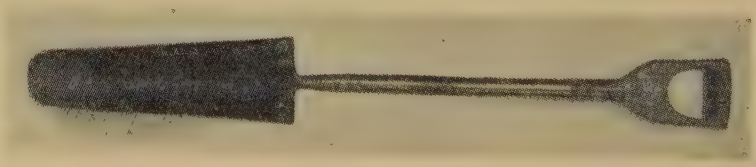
Fig. 12a depicts six suckers taken from a one-year-old plantation, and only E and F are fairly suitable plants for propagation purposes. Note the area that had to be severed from the side of the parent to permit the removal of suckers E and F.

Taking the well developed plantation as the grower's best guide, the best type of sucker to select must be considered. Opinions vary even amongst experienced growers as to the stage suckers should reach before removal for transplanting. The fact is generally acknowledged that the later in the spring suckers are removed the better, but it must not be forgotten that the plant or sucker planted late may have to commence its new life under rather severe climatic conditions on the Gascoyne. Suckers six to eight months old are favoured by some growers, their method being to eliminate the centre growth and allow the first followers to produce the first bunch. When using this type of plant, if this practice is not adopted, the grower may anticipate an early bunch of rather inferior fruit compared to the bunch that would be carried by the first follower were the original centre growth destroyed.

The size of the sucker is not a true guide to quality for the rapidity of growth of suckers varies tremendously. The main points to keep in mind are that plants should possess good solid bulb formation with the pseudostem or barrel of the plant a maroon or dark brown colour and tapering from the bulb to the apex, the leaves growing fairly upright being small and narrow; such type suckers are commonly known as "spear points" or "sword" suckers. Strictly avoid suckers with small bulbs possessing barrels of more or less even girth from bulb to apex, with broad spreading leaves. These are known as "umbrella" or "water" suckers and are slow developing plants producing inferior bunches. Fig. 11 describes good type spear points or sword suckers removed from three-year-old stools and are far superior to all suckers in Figs. 12 and 13.

Removing the Sucker.

The utmost care should be taken during the operation of removing the sucker from the stool both for the good of the sucker and parent plant. The mattock, shovel or hoe are not very satisfactory tools for severing the sucker, and the operator should use a suitable bar, similar to a crowbar, the blade of which should be long, flat and wide and possessed of a sharp edge. For convenience of working the blade portion of the bar may be set at an angle to the main shaft of the instrument, the whole implement being of sufficient weight to give a good fall.



A draining spade is also a very useful tool for removing suckers.

The soil should be removed from between the parent plant and sucker so that the operator can detect the union of the two plants. The bar is then placed at the narrowest part of the union and forced downwards. With large suckers it is necessary to remove soil from both sides before attempting the removal, and it may be found necessary to aim the bar at the point of union of the two plants. Never attempt to remove plants that are wedged between two adult plants,

for not only is the young plant likely to be damaged, but considerable root surface on the adult plants will be destroyed. The entire operation should be one of gentleness—no more force than necessary should be used when loosening the sucker. With the most careful and methodical operator there is likely to be a percentage of damaged suckers and these should be discarded. The honest vendor will not supply damaged or otherwise unsuitable plants that he himself would not plant.

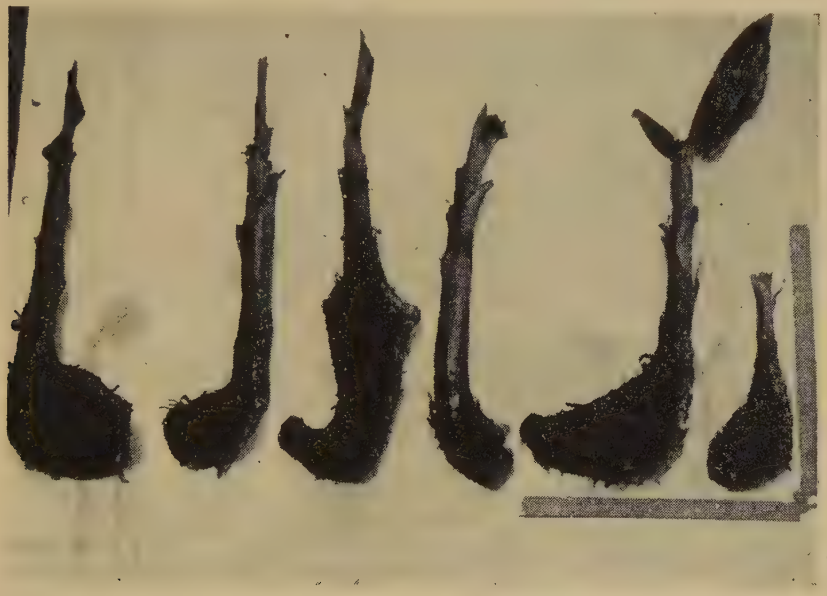


Fig. 10.—Inferior type plants from declining or run out plantation, unsuitable for planting.

Fig. 11.—Depicting good type spear points. Note size of corm and tapering top.

Fig. 12.—Inferior type plants that should never be used. Note corky rings around shoulder of corms.

A B C D E F

Fig. 12A.—Suckers from one year old plantation.

After Removal.

All leaves should be removed to minimise transpiration and all roots cut off close to the bulb or corm. With large plants it is advisable to cut back the top portion of the barrel to within about eight inches of the crown of the bulb in

preference to only removing the leaves. The cut should be made on the slant and high enough up on the stem so that when the sucker is planted the irrigation water will not cover the cut surface (this point relates more particularly to late planting). Where suckers as depicted in the centre plant of Fig. 13 are being used as planting material it is optional to remove any of the top growth. As a precaution against fungal infection of the sucker after removal from the stool the cut surface of the plant may be turned to the sunlight for several days when the sappy surface will harden and thus reduce the possibility of corm trouble. This precautionary measure should also be adopted with cut up butts but is not recommended in the case of suckers from year-old plants. The habit of certain growers of rubbing the freshly cut surface of the sucker or bits in the soil is a bad one, as this action is liable to introduce soil fungi and bacteria which may mean decay of the corm early in the life of the young plant.

Fig. 13.—Material from vigorous one year old plantations removed late in planting season. These have a tendency to be soft and require immediate planting after removal. Not recommended for Gascoyne conditions.

All propagation material should be free of all soil and roots prior to removal to the intended planting ground. This precaution is necessary so that disease and pests which harbour in and about the corm may be detected. If plants are being used from an old plantation or one heavily infested by nematode or eel-worm it is advisable after cleaning the plants, to dip for an hour in corrosive sublimate (1 oz. to 6 gls. water). Care should be exercised in using this material as it is a powerful caustic agent and very poisonous.

Plants with prominent brown corky rings around the shoulder or top of the corm should never be used as these rings usually indicate aged or stunted growth. (Fig. 12.) No doubt this type of plant will grow but will produce an inferior bunch and followers.

Bulbs or corms which show decay or reddish brown strands on the interior should be discarded. The slogan "if in doubt throw it out" is worth while.

In other banana producing countries the grower adopts the term of "so many acres of bananas" but in W.A. it is customary to speak of so many thousand plants. Possibly this is a very wise method of describing an area of bananas, for it tends to indicate so many "producing units," the grower possesses. After all, each plant or each stool should be made to produce to the maximum. A poor or weak plant takes just as much manure, just as much water and attention as a good vigorous plant, but does not return in £ s. d. a corresponding amount of revenue, so start right by planting right.

"Banana gauge" or "de-suckering bar."

De-Suckering.

The pruning or reducing of surplus sucker growth from around the plant or stool is necessary if large marketable bunches of fruit are required. With this object in view the grower must formulate some method whereby this work can be carried out most efficiently. The entire digging out of the surplus suckers is not recommended as to do so necessitates the destruction or damage of much root surface on the remaining plants, which naturally must have a detrimental effect on the forthcoming bunch. The work can be most successfully carried out by the use of what is termed a "banana gouge" or "de-suckering bar." By the use of this implement the growing point of surplus suckers can be destroyed without in any way disturbing the root system of the parent plant. This operation is best or most easily carried out when the surplus suckers are about one foot high; if the suckers are allowed to develop to a more mature age the work of de-suckering is increased and in the meantime, unnecessary sapping of plant food is occurring.

The plant to be removed should be cut off at ground level with a sharp knife. The point of the gouge is then inserted just inside the outer edge of the base of the plant and with a little pressure and turning of the handle in an auger-like fashion the heart of the corm or bulb can be lifted out. The heart of the corm can be detected by the close white-grained tissue compared with the other parts of the corm. Until the operator has become accustomed to detecting the heart section, it is suggested that he gouge right through the corm into the soil, when he will be satisfied that the vital portion has been destroyed.

Stooling.

The number of suckers that should be left around a stool depends upon such factors as the age and condition of the plantation, distance apart of stools, soil conditions, etc. In the case of a year-old stool no more than three followers of various ages should be allowed, and these should be so located that each one is as far apart as possible around the stool (see page 100). In the regulation of suckers around a well developed stool, the main object should be to select offshoots of varying age so that not all plants are maturing their bunches at the same time. Three adult plants with three followers is quite sufficient growth to allow to remain if large bunches are required. Elminate suckers that develop between the adult plants or in the centre of the stool as these suckers will seldom produce commercial bunches. The type of offshoot to leave can be selected on the same points that have already been mentioned when selecting propagation material.

In selecting the most suitable suckers as followers, endeavour to retain the suckers that develop well away from the parent. Not only will it be found that these usually produce faster and better bunches than suckers developed close to the parent, but as the former develop or shoot from eyes low down on the parent corm, they are naturally deep rooted and therefore, assist to prolong the life of the plantation, which often becomes unprofitable not on account of soil poverty, but on account of the plants rising to the surface and falling over in light winds following upon irrigating. Each generation of plants should be formed from the generation immediately before it, i.e., avoid leaving two followers from the parent plant.

Irrigation.

No set rules have been laid down for irrigation practices and applications of water must be judiciously handled by the individual grower according to the type of soil, the system of planting, layout, length of rows and amount of

water available. The general practice is to irrigate every week in the summer, and every fortnight in winter. Should severe heat be experienced, it is necessary to apply water more often during the summer months. It behoves the grower to have a unit and plantation layout that will enable him to irrigate his entire area in less than a week, and so not only avoid being continually tied down to

One year old plant showing correct spacing of the following suckers of various ages.

his property seven days a week with irrigation duties, but to enable a quick return of irrigation waters in the event of heat waves or after mechanical trouble in his pumping unit.

An irrigation should be applied to the plantation as soon as possible after manuring or the removal of suckers for planting.

Sixty thousand gallon ground surface storage tank under construction.

If finances will permit, the grower should have more than one irrigation unit, and keep on hand essential spare parts for his pumping unit. Some growers have erected 40,000-60,000 gallon tanks built on the ground level, and these appear to be a good investment in that they permit a useful storage and head of water, which can be built up after the close of the day's labour in the plantation.

At the moment, considerable interest is developing into the possibilities of "overhead irrigation" and already several growers have installed small units. While this system would eliminate considerable preliminary work and cost in the laying out of a plantation, the initial cost of the system is heavy. Overhead irrigation trials are being initiated at the Tropical Research Station and growers are advised to await these investigations before expending any money on this system. It must be remembered that the low rainfall and sharp dry atmosphere

of the Gascoyne has many benefits for the banana grower, especially in the suppressing or keeping under control of many foliage and fruit disease which might otherwise develop under more humid or wet conditions particularly during the cooler months of the year.

Ploughing typical Carnarvon banana land.

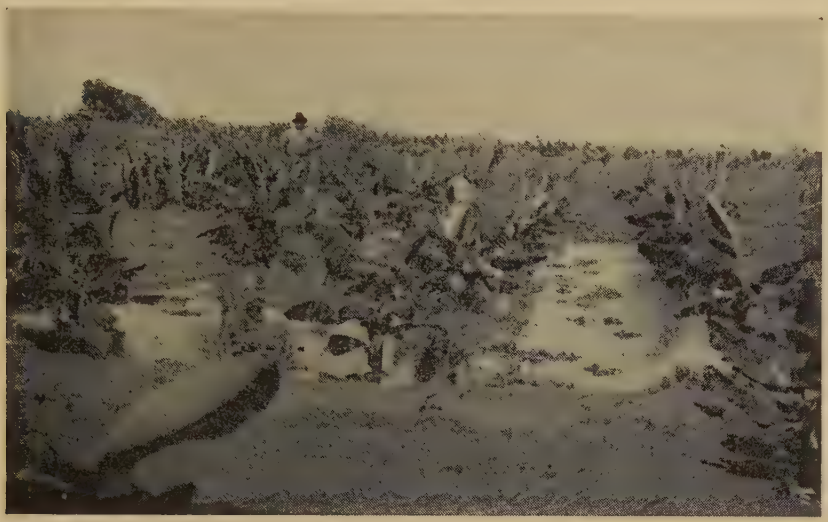
Easin method of planting and irrigating.

Furrow and hole method of irrigating.

Fig. 14—Flooding system of irrigating banana plantation, five months old plants. Note how irrigation row has been widened. See Fig. 9.

Furrow and hole method of planting and irrigating suitable for long rows.

Extravagant irrigation drain. This should be a quarter of the width and cemented See also Fig 7B



Flooding method of planting and irrigating. Not recommended for most Gascoyne soils.

A galvanised iron troughing type of irrigation drain that is in good order after 10 years' service. This type of irrigation line is portable (from one site to another.

Removal of Tassel or Flower Ball.

Opinions vary as to the advisability of removing this from the plant. Some authorities do not favour the removal owing to the bleeding that occurs, but under trials carried out at the Research Station, there are indications that the lower hand develops better and that the bunch has a tendency to mature earlier when the tassel has been removed. The most favourable time to remove the tassel is after the third set of "neuter" flowers have died and the tassel stalk will snap off when bent at right angles to the bunch.

A scene in a William Hybrid (Golden Gros) plantation.

Trashing.

The grower should make it a practice of periodically going through the plantation and cutting off the dead leaves. There should be two main trashings, in the autumn and early spring, or just after manuring. On no account should the dead leaves be removed from the plantation. The leaves although highly loaded with water, contain valuable plant food and should where possible, be turned into the soil or left on the surface to act as a mulch.

The advantage of trashing is that, particularly in the winter, sunlight is allowed to penetrate the barrel and create warmth to the growing plant, as well as expediting the early development of suckers for early spring planting, which is so desirable under Gascoyne conditions.

Manuring.

It has already been mentioned that Gascoyne soils are low in organic matter so it is highly desirable to maintain green crops in the young plantation as long as possible. (Figs. 15A, 15B, 15C.)

After the first year of banana growth it is not found practicable to grow a satisfactory green crop owing to the canopy of banana foliage and therefore artificial means of supplying plant food are resorted to.

It is possible that it is during the early stages of the banana plant's life—first six to eight months—that the most care and attention to availability of plant food and moisture is essential and will largely determine the type of bunch eventually to be harvested. Some authorities claim that fertilizers have little or no effect upon the bunch if applied after the plant is eight months old. Experiments at the Gascoyne Research station support this opinion as the bunch is joined in the corm during the first eight months of the plant's life and after this stage irrigations appear to only assist to fill out the fruit and do not increase the number of hands or number of fruit on the hands.

Fig. 15A.—Cover crop of cow peas in young bananas.

Under normal conditions ample supplies of organic manure are obtainable direct from the Wyndham meatworks and highly satisfactory results have been obtained by growers after applying blood and bone at the rate of 5 or 6 lbs. per plant per annum—in the early spring and again in late summer. These manurial applications are often supplemented by light dressings of sulphate of ammonia of 2 to 3 ozs. per plant per month. Applications should be made within a radius of two or three feet of the plant. Rather comprehensive manurial trials were initiated at the Research Station but these, unfortunately, were abandoned owing to war conditions before conclusive results were obtained. These trials embraced organic and mineral fertilisers, method of application, placement and frequency and will again be put under way as quickly as possible. During the shortage of manures over the past few years it has been found advisable to make one good application of manure in preference to a series of small applications. This applies particularly to organic applications such as blood and bone.

Keep in mind that excessive applications of nitrogenous manures, while producing prolific vegetative growth, can be harmful to the banana in that the carrying, keeping, and flavour qualities can be impaired.

For the present the new grower is advised to adopt the general manurial habits of successful growers.

Pests and Diseases.

Although the banana plant is subject to many serious diseases in other banana producing countries, the Gascoyne district is fortunately free of any of the major pests and diseases. A very rigid quarantine is kept of any plant material entering the State. However, should growers at any time suspect trouble within their plantation it should be immediately communicated to the Department for investigation in preference to any attempt at concealment.

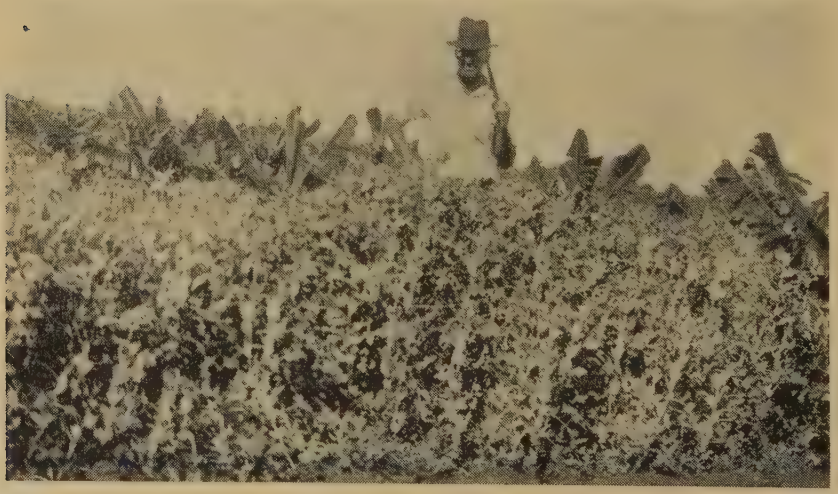


Fig. 15B.—Clover crop of field peas amongst young bananas.

Cultivation.

Providing thorough methods have been adopted in the preparation of the land prior to planting there is little need for intense cultivation during the life of the plantation. During the first year if green crops have been grown it is safe to use the plough, or similar tool, at a shallow depth but on no account should these implements come within a radius of several feet of the plant.

Normally the manure is turned in with a hoe and this should be used with considerable caution in close proximity to the plants.

Weed Control by Spraying.

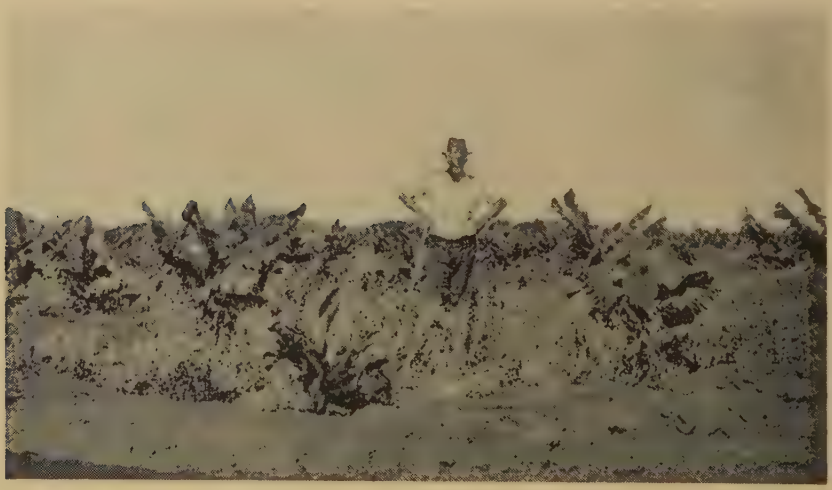
During the early life of the plantation, opportunity to combat weeds by cultivating is often not possible with the result that the weeds are allowed to seed making this future control more difficult.

As most settlers possess a knapsack or other small portable spray outfit, early and speedy weed control is possible by the applying of a weedicide to the troublesome area. While there are several proprietary lines on the market, the following formula will give satisfactory results, especially on the more succulent type of weeds, if applied in the early stage of their growth. Use 1 lb. of arsenic, 1 lb. washing soda, or ½ lb. caustic soda and 12 gallons of water. To act as a spreader to this solution should be added soap or phenyle at the rate of 1 oz. to the gallon of spray.

This spray may be applied as frequently as necessary without any apparent effect upon the soil for banana growing. As the spray is a poison, every human care should be taken.

Fig. 15C.—A clover crop of rice beans amongst young banana plants.

Cover crop of field peas with light dressing of sheep manure.



Cover crop of field peas without dressing of sheep manure.

Handling the Fruit.

With increased production in sight from the Gascoyne Settlement and the possibilities of greater competition from outside sources, it is highly desirable that all growers adopt the best possible methods of handling their fruit in the field, at the packing shed, and in the final presentation, the shop windows, via Metropolitan Markets.

If the Carnarvon product is to retain and extend its good name throughout the State inferior quality lines must be kept from passing "over the rollers." At the same time inferior fruit presented to markets may not only prove a loss to the grower but its presence tends to depress prices for better quality fruit.

The buyers on the markets are experienced and keen business men and the grower who puts up the good pack of good size fruit is sometimes a poor attraction to them, simply because the grower has failed in his attention to one or more of the links in the chain of "preparation for market." The grower's watch words in preparation for market might well be "Carefulness, Cleanliness, Coolness," remembering that no grower can deceive the retailer who handles every banana before presenting them to his customers, also that the final judge of your fruit is, in the majority of cases, a thrifty housewife and it is her, through your agent, wholesaler and retailer, that you must satisfy if you wish repeat orders for your fruit.

Bananas passing "Over the Rollers." A scene on the Metropolitan auction floor. Note serious shrinkage of fruit pack in cases in foreground.

Varieties.

While there are at least a dozen types or varieties growing in the Gascoyne, there are only two grown commercially, those being the Cavendish and Golden Gros or Williams Hybrid which is a mutant of the Cavendish. Other mutants of the Cavendish growing at the Research Station are Mons Marie, Veimama, Samoan China, and are growing quite successfully along with the Lady Finger, Sugar, Gross Michel. Several local Cavendish mutants are being tested out at the station.

The Sugar Banana.

The Cavendish Banana.

The "Lady Finger" Banana.

Harvesting the Bunch.

It is somewhat difficult to state the period at which the bunch should be cut. To say that a bunch is ready to cut when the fruit looks mature and well filled is not sufficient. This is a matter requiring a considerable amount of judgment, especially after abnormal weather conditions. Cutting time depends upon the season and condition of the plantation. In summer-time fruit should be

cut several weeks earlier than during the winter months. The hanging and keeping qualities varies with varieties. For instance, the locally known Golden Gros (Williams Hybrid) variety will hang longer than the Cavendish, but very full friut of the former variety does not have the keeping quality, when ripe, as that of the Cavendish so that it is advisable (during summer months) to cut Golden Gros bunches a little earlier than in the case of Cavendish.

Harvesting operations should be carried out during the cool of the day. In summer time this is very advisable when the cutting should be done as early in the morning as possible. Avoid cutting late in the afternoon or evening in summer, while the fruit is warm, as such fruit is liable to possess poor keeping qualities.

When cutting the bunch, considerable damage may occur to the fruit if care is not taken by the harvester. It is advantageous to have an assistant when cutting heavy or tall growing variety bunches, so that one man can grasp the bunch by the stalk while the other severs the bunch. If this is not possible, the weight of the bunch must be borne by the operator by allowing the bunch to lie against the body while the stalk is cut. Avoid letting the bunch drop or rest on the bare ground for the lower hands will be blemished. The bunch, if not removed immediately to the packing shed, should never be laid down for fear of injury to the fingers at the stem ends, but should be stood upright on clean banana leaves or trash where the fruit will not be exposed to sun or wind. Where and when ever possible, bunches should be stood in an inverted position (that is, in a reversed position to which it hangs on the plant).

By adopting this method the lower hands will not be blemished as is so often the case. Never carry the bunch on the shoulder, as much fruit can be bruised in this way. If the fruit is to be carried by hand to the packing shed the job can be accomplished more comfortably if a yoke is used (Fig. 16). Everytime a bunch is handled some damage is likely to occur to the fruit and what may appear to the harvester as only slight harm to green fruit may reveal itself as

Young bunch, Cavendish variety.

A mature Cavendish bunch ready for cutting. Note the full round appearance of the fruit.

a major fault when ripened. It shou'd be the grower's aim to handle the bunches as seldom as possible between cutting and nailing down. Seldom is it realised that the fruit is disturbed on an average of 12 times from the cutting of the bunch to being packed in the case. The method of handing fruit by one Gascoyne settler is worthy of recording. This grower, upon cutting the bunch, pierces an "S" shaped No. 4 gauge wire hook through the stem of the bunch and if the fruit is being conveyed by manpower to the packing shed a yoke is used and instead of having ropes attached to the ends of the yoke there are suspended wires with iron rings. The "S" hook in the bunch is then hooked into the ring on the yoke and conveyed to the packing shed. Upon arrival at the packing shed the bunch is suspended from overhead bars and is immediately hosed down with water. (Fig. 17.) (This latter action is not new to the banana world but has added benefits to Carnarvon bananas owing to the dust and high arid climate conditions. The washing of bunches is therefore highly recommended, for this action removes dust, prevents sap stain after dehanding, tends to keep fruit and shed cool and gives the fruit a decidedly brighter appearance when ripe.) Consideration should be given to the removing of the dried flowerettes from the fruit just prior to washing down of the bunch.

A bunch of William Hybrid (Golden Gros). This bunch weighed 110 lbs., length 4ft. 2in., girth 65in., marketable fruit 363.

Fig. 16.—Carrying bunches to shed on a yoke.

Fig. 17.—Bunches on rack dry off after being hosed down just prior to dehanding.

Dehanding.

When cutting the hands from the bunch a supple, narrow-bladed and pointed sharp knife will be found most useful. (Fig. 18.) A smooth semi-circular cut should be made so that a portion (about $\frac{1}{4}$ inch) of the cushion or flange is retained by the hand. (Fig. 19.) Too often is this operation carelessly performed and it should be recognized that it is very necessary that when the hands are broken into fingers that each fruit should possess a small portion of the flange

or corky wood at the stem-end. This prevents the fruit from shrivelling, gives the stem-end a full and well shaped appearance when ripened and will assist greatly in protecting the fruit from black-end, stem-end rot and other fungi troubles which are responsible for considerable wastage in what would otherwise be prime fruit. Harm can also occur through cutting the hand and leaving too much of the flange attached in that when breaking off the fingers at packing time the stem-end of the fruit may be strained, bruised or the skin torn.

Dehanding incorrectly may defeat all the care and attention that a grower might otherwise give to his fruit and pack. Stem-end defects whether black-end, shrivelling, torn skins, etc., detracts from the fruit's appearance in the ripened case and shop window. Remember all cases are opened from the side for inspection and stem-end defects will immediately be seen by the buyer. To the consumer the fruit may look faulty, stale or unsafe and the retailer fully alive to the sentiments of his customers will either pass the fruit by or offer a low value to the wholesaler or agent. The cost of a sheet of sponge rubber matting, on which is placed the bunch at dehanding, is well worthwhile. Some growers use a folded piece of sacking but even then the fruit on the bottom hand are blemished.

Bunches hanging in the packing shed awaiting dehanding.

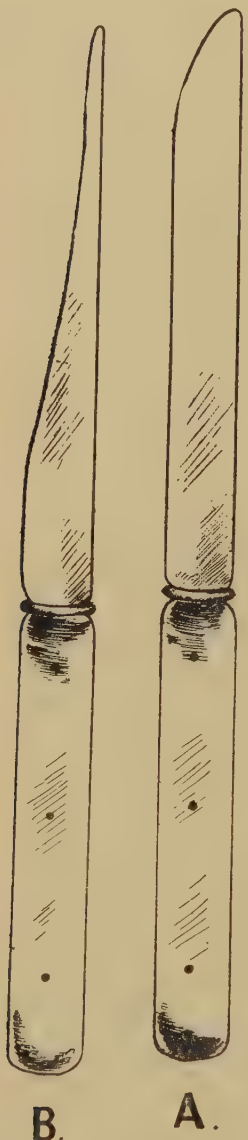


Fig. 18.—"B" a good type of cutting knife compared with an ordinary rounded end type "A."

Refrain from straining the individual fingers when dehanding well curved fruit. With difficult placed hands it is better to make two cuts—one to remove the hand and the other to trim down the flange to the desired length of ¼ inch. Do not let the hands fall on the floor. (If labour is available dehanding can be carried out more speedily and efficiently by two men—Fig. 20—one man dehanding and the other taking away and stacking.) Do not throw or drop the hands on the bench, but stack carefully on the bench in concave (downward) fashion and in such manner so that as little as possible of the sap from the cut flanges drain on to the hands lower in the stack. (Fig. 21, A and B.) To facilitate packing movements the fruit should be carefully stacked in different grade heaps at time of dehanding. The practice of breaking up the hands at dehanding time and stacking the single bananas in grade heaps is not only adding to labour and time but causes extra handling and blemishing of the fruit.

The fruit, after dehanding, should be allowed to sweat for 12 to 24 hours prior to packing in winter, but this period can be greatly reduced during summer. Effective sweating cannot be obtained by allowing the hands to remain on the bunch, so dehand one day before packing. During summer months, and even during easterly wind days of winter, the covering of the dehanded fruit with damp sacks or some other coarse material is advised. Endeavour to avoid packing fruit while wet and hot. Too much emphasis cannot be stressed upon the necessity for *all* growers to strive to keep their fruit cool at all times, especially during packing shed operations. Repeatedly has the Carnarvon product gained great popularity in the metropolitan area only to lose considerable ground during the summer months, the common complaint from retailer and consumer alike being that our fruit lacks colour and does not keep. This complaint is gradually being overcome with the greater realisation, by growers and carriers of the necessity for keeping the fruit cool. Keep in mind that the ideal temperature for long life in the banana is 50-60 degrees. This cannot be achieved by the grower but he can do a great deal towards that point. A packer can often be deceived during the summer months by rising temperatures and an investment of a few shillings in a wet and dry bulb thermometer or unsheathed thermometer will prove of value and great interest in the packing shed.

Fig. 19.—A correctly dehanded hand of fruit.

Another view of hanging bunches awaiting dehanding. Note hands on bench in background.

Fig. 20.—Dehanding. Note bunch sitting on rubber pad.

Fig. 21A.—Scene in packing shed. The way NOT to stack hands.

Fig. 21B.
Correct way of stacking hands.

Fruit carelessly stacked on bench and exposed to sun. This treatment is bound to give short life and impair the quality of the fruit when ripened.

Scene in packing shed. Fruit stacked ready for packing. High stacking such as this not advisable owing to the possibility of excessive weight damaging fruit at bottom of stack.

Packing Shed.

As the packing shed is the last place where the grower has personal control over his product, comment would not be out of place concerning the growers "dressing room" of his labours. It must be admitted that many packing sheds are crude and inconvenient structures, especially for the handling of such a delicate fruit under the extreme summer conditions that are at times experienced on the Gascoyne. Official records have revealed that more fruit is heat affected in the packing shed than at any other point in the handling of the fruit.

It is not suggested that an expensive or elaborate building should be erected as a packing shed, in fact this is not necessary. The building should be in as centralised a position as possible, so as to facilitate the handling of the fruit from the plant to the packing bench. The building should be well ventilated and the floor should be cemented, with a gradual slope to permit copious watering and draining and made spacious enough to avoid cramping of packing movements. Earth floors are not only objectionable on account of being dusty or muddy but there is ample evidence to indicate that the few bags of cement required for the work of cementing the floor will eventually repay the grower with the increase in price gained for cleaner and healthier appearance of his fruit

Fig. 22.—Packing house made of banana leaves or trash.

The advantages of abundance of light and ventilation are obvious and every extra foot in height given to the roof will be of benefit.

If the roof or sides on a building are of iron it should be covered with green creepers as speedily as possible. An economic shed can be made with hessian sides that may be rolled up or down. There are various types of local material available for the covering of packing sheds. The Nor' West or Worramel creeper makes a rapid and splendid covering but owing to its profuse flowering and fruiting habit it encourages rodents to make it their habitation and eventually they attack fruit stacked in the shed. An excellent cool and long lasting shed can be very economically constructed by erecting double walls of wire netting in between which is packed banana trash. (Figs. 22 and 26.) Another splendid cool and long life shed can be erected from palm leaves, reeds or Yangie grass. The walls of such buildings can be watered during summer and a considerable drop in temperature attained. The watering of the walls can be ideally carried out by the erection of a small overhead tank connected to a small pipe line placed

round the top of the sides of the building. Small holes are bored every 4-6 inches along the side of the piping. The piping should be erected with the holes facing downwards. An ordinary garden sprinkler running on the roof is an agent towards reducing high temperatures.

Packing Shed Layout.

The layout within the shed should be such that will secure the greatest saving in time and handling. The bunches should enter one end of the building and the entire handling be so arranged that the packed cases are delivered to the truck at the opposite end of the shed.

The habit of packing fruit from the floor is to be discouraged. The cost of benches is not very great and should reduce the amount of damaged and dirty fruit, at the same time giving considerable more floor space. All possible means should be adopted to prevent the fruit coming in contact with soil for it is quite possible that this can be responsible for disease and decay that develops after the packed cases are forwarded to ripening rooms or markets.

Benches should be approximately 30 inches high and the floor of such covered with bags or hessian that can be readily removed for hosing down and cleaning.

While these suggestions, if adopted, will go a long way towards economic and a better presentation of the product the efforts of the grower may be defeated if strict attention is not paid to cleanliness. Finance may restrain some growers from erecting spacious and otherwise suitable sheds but there can be no excuse for dirty and untidy conditions within any packing shed. The shed and benches should be swept out just prior to bringing in of the bunches and immediately after the packed cases leave the shed. All stems, waste fruit and other rubbish should be carted well away from the packing shed and shed precincts, and destroyed.

Fig. 23.—Method of holding the hand of banana for breaking. The weight of the fruit is supported by the arm, preventing any possibility of strain on the shanks of the fruit.

Breaking the Hands.

If the hands have been cut correctly from the bunch the breaking up of the hands into singles or clusters is a simple operation but there is a correct and incorrect method. The hand of fruit should be placed in convex fashion in the packer's outspread hand with the stem-end of the fruit facing towards and close to the wrist. (Figs. 23 and 24.)

Fig. 24.—Breaking bananas from the hand. Note how the fruit is held by the shank.

The individual fruit is then grasped firmly by the stem-end and with a semi-circular motion is broken off the hand.

Holding the hand by the calyx or flower end of the bananas or of holding the individual fruit at the flower end is not advisable for these actions may cause damage to the fruit at the stem-end. The harm is not apparent until the fruit reaches the ripening rooms or markets. Consideration might be given to cutting the hands into singles in lieu of breaking. Cutting certainly gives the banana a better appearance when ripened.

The case should be well constructed of clean neatly cut timber, with the even spacing of all boards and the straight driving of all nails. Use nails of suitable length, especially when making up ends when the nails should be slightly longer than the thickness of the cleat and case end to allow clinching of the ends of the nails on the inside of the case ends. Nails that protrude through the sides of the ends of the case should be either withdrawn or hammered down otherwise a grower is courting trouble during the handling stages of the packed case in the event of injury to the carrier who may, in false justice for injury occurred, drop the case in no uncertain fashion. While the standard tropical fruit case is used entirely in Western Australia, consideration should be given to the new case which has been adopted in the Eastern States and the 1½ bushel case discarded. The new case is similar to the 1½ bushel tropical case

except that it is four inches shorter in length. It is claimed for this case that there is less bruising of the fruit, less case breakage owing to elimination of much rough handling, and that sales are increased.

No one will deny that an unattractive container tends to mar the contents of any product and the banana case is no exception. Far too often is observed the careless and by no means neat stencilling. At times stencil markings are difficult to read and this will at times cause extra handling when sorting at Fremantle. It also appears that some growers' cases carry too great an amount of stencilling. There is need for the standardising of stencils amongst growers. The agent's name could be abolished and either a number or letter substituted. This would eliminate the conglomerate of stencilling that is to be seen at times.

The Gros Michel Banana.

Under the Fruit Cases Act growers are required to brand or stencil their cases with letters or figures not less than three eighths of an inch in length, setting out the name of the district, name of fruit and the quantity in bushels. In lieu of the name of the grower a brand may be used providing such brand has been approved and registered by the Department of Agriculture. A fee of seven shillings and sixpence is the cost of a registered brand. Place your stencils so that the lettering is parallel with the cleats on the end of the case. Stack shooks and made up cases in a sheltered and shaded place. Avoid packing into cases that have become hot through standing in the sun.

Grading.

At the present time there does not appear to be uniformity of grade sizes amongst growers and it is very desirable for the industry as a whole that an effort be achieved towards standardisation of the banana. At present growers are adopting the practice of banana districts in the Eastern States by stencilling their cases "sixes," "sevens," "eights," "nines," but while the individual grower may be consistent with his packed contents, there is a lack of uniformity amongst the growers collectively.

Standardisation of grades will go quite a long way towards the producers desire for the stabilisation of markets.

While it is the writer's desire to see a co-operative effort for uniformity of grades it is not intended to dwell upon this desire in these notes, and, for the present, it should be the objective of each grower to determine a standard grading formula for his own use and to maintain it.

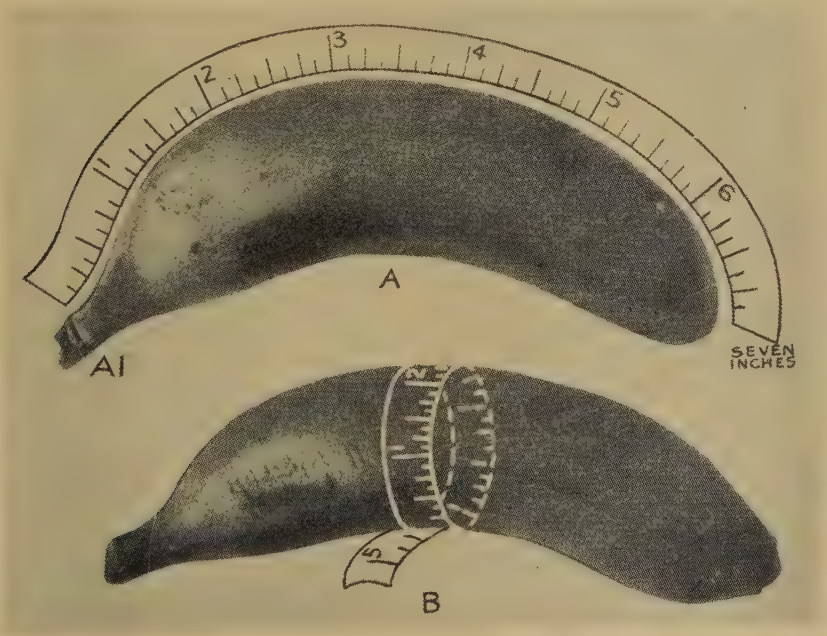


Fig. 25.—Method of measuring the length and girth of a banana: A. The length of the fruit is taken from the raised girdle (A1) to the centre of the end. B. The middle of the banana is where the measurement for the girth is taken.

The following grade standards are recommended:—

"Smalls": Fruit not less than 5 inches but less than 6 inches with minimum girth of 4 inches.

"Sixes": Fruit not less than 6 inches but less than 6½ inches in length and 4 inches in circumference.

"Sevens": Not less than 6½ inches but less than 7½ inches in length and 4 inches in circumference.

"Eights": Not less than 7½ inches but less than 8½ inches in length and 4½ inches in circumference.

"Nines": Not less than 8½ inches in length and 4¾ inches in circumference.

The length of a banana is measured on the outside of the curve from the junction of the fruit at the stem-end to the apex or calyx end of the fruit. (Fig. 25.)

At present, under Prices Regulations, selling by weight has been almost universally adopted by producer and retailer and whether at a later date the pre-war custom of selling by count will again operate is a matter of conjecture.

The present method certainly is not in the best interest of the consumer for the additional handling by weight tends to bruise the fruit and also adds to the labour of handling by both wholesaler and retailer.

Fig. 26.—Correct packing position. Note cement floor, stacking and packing benches, ventilation and ample light in building, all helping to complete a good pack.

Packing.

There are several methods of packing such as in hands, part hands, or clusters and singles. There is no doubt that the packing in the full hands is the ideal packing method but there are a few difficulties experienced if the fruit

and hands are not all of similar shape. The part hand or cluster pack is next in preference and apart from greater speed in packing, less damage, less black-end and stem-end trouble is likely to occur to the individual fruit than when breaking the full hands into singles. With the cluster pack it may be permissible to work two grades in the case.

Consideration might be given by growers to the use of the cluster in preference to the singles pack. This pack was adopted for a short time by one grower and met with only fair support from buyers but the objections then raised can be overcome with the present improved cultural methods and more even type fruit. One of the buyers' main objections to the cluster pack is that the case does not contain the "count" as that in the single pack. With a little experience in packing cluster fashion, the grower will pack practically the same count as with the single pack. He will also find that less time and labour are required. (This factor is also to the advantage of the retailer.) Clusters ripen with a brighter and fresher appearance especially at the stem-end than in the case of singles.

While the single pack is the present standard on the Gascoyne and most growers should be conversant with the various ways of packing singles, there is evidence that these operations cannot be too frequently described.

Fig. 27.—Method of packing first layer of "sixes" and "sevens." Note how last banana is turned downwards to give a tight lock to line of fruit.

The packer should stand at one end of the case and not at the side as is sometimes seen. (Fig. 26.) The end of the case furthest away from the packer should be slightly raised. All layers of fruit should be commenced at the end nearest the packer. With the packer at the end of the case and with the opposite end of the case slightly raised it will be found that the packer can pull the fruit gently into position, especially when placing the bottom layers in the case and thus assuring a firm foundation to the eventually packed case.

In commencing the pack with average "sixes," "sevens" or "eights," two rows of bananas are laid gently on their sides along the bottom of the case with the stem-end of the fruit touching the sides of the case. (Fig. 27.) The first layer must be packed firmly for if the foundation layer is loose the complete pack must be loose. Particular attention should be paid to the last fruit in the first rows, where the last fruit in the rows should be made to act as a lock on the fruit in the row. Fairly straight fruit can be used to advantage for this purpose.

Similar shaped fruit can be used to advantage in the centre between the two rows and they should be packed firmly into position so that the stalks of the other fruit are pressed firmly against the sides of the case (Figs. 28 and 29). Remember that once the case is nailed down the case from thereafter is laid on its side and any slackness in the centre of the pack will permit the layers to move causing damage to the fruit. Various methods of packing the centre of the case are depicted.

The second layer of fruit is placed on top of the first rows in the spaces between the fruit. (Fig. 28.) This fruit can either be placed concave downwards or on their sides. Whichever method is used it should be uniform throughout the placing of this layer. With long stemmed fruit it is advantageous to place the second layer of fruit on their sides as this will avoid damage to the stems when the bulge is placed on the lidded case.

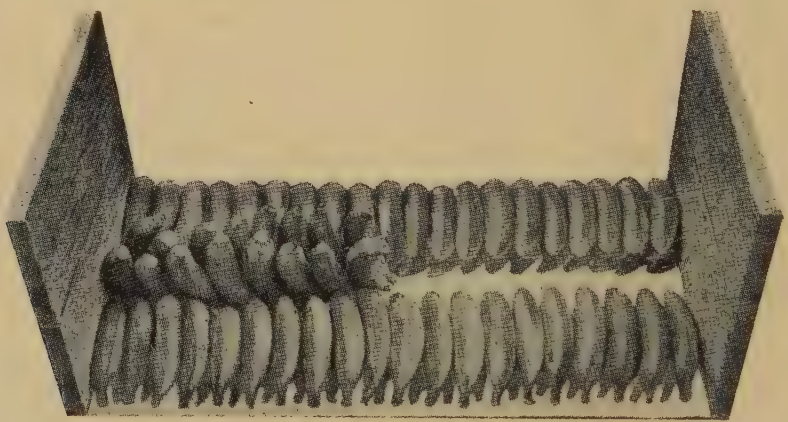


Fig. 28.—Method of placing second layer. Fruit should be placed as far as possible, in the spaces of the first layer, concave downwards. Note the vertical method of placing the centre fruit when pegging which may also be placed concave downwards.

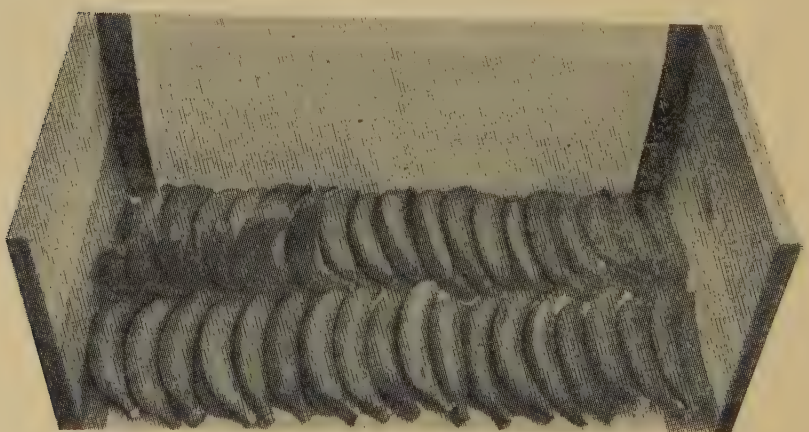


Fig. 29.—Showing placing of centre bananas.

Fig. 30.—In each layer the fruit is placed in the spaces between the fruit of the previous layer.

The third and subsequent layers should be placed concave downwards in the spaces between the fruit of the previous layer (Fig. 30) making sure that the stem-ends of all fruit go well down on the sides of the case but not so that the shoulder of the fruit itself touches the case. As the case is being filled layer by layer make sure the centre is firmly filled with fruit of the same grade as the remainder of the case. **Do not use smaller fruit for the centre.** (Fig. 31.) The last two layers may be made up of nicely curved fruit that will give the pack a very attractive appearance and will also facilitate and avoid stem-end damage when nailing down the lid. (Fig. 32.) The last layer should come above the top of the case but just how high the pack should be will depend upon the quality of the fruit. This point is soon gained by experience and the correct bulge after the case is nailed down should be 1-1½ inches. Finished packs of sixes, sevens, eights. (Figs. 33, 34, 35.)

Fig. 31.—Fruit removed from centre of a case of "sevens" at Metropolitan Markets. Note uneven grade of fruit and damaged stem and blossom ends.

Fig. 32.—Nicely curved fruit for top layers.

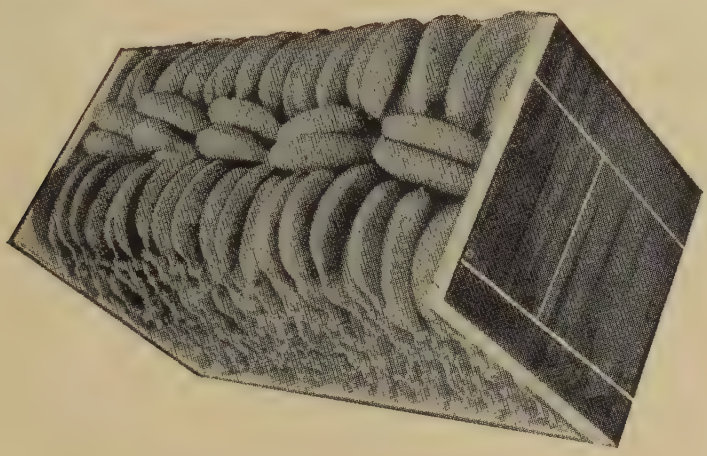


Fig. 33.—Finished case of "sixes."

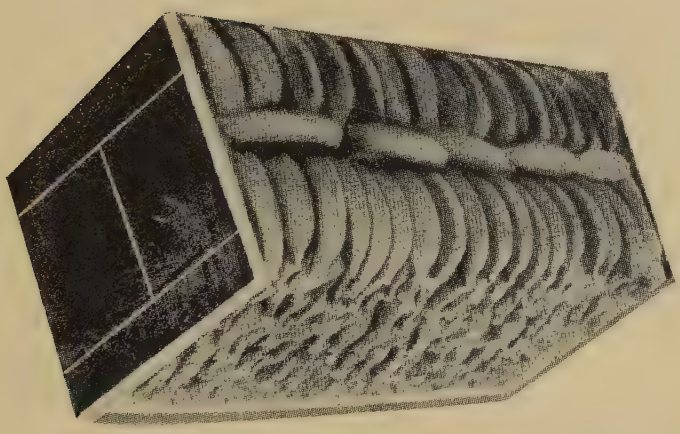


Fig. 34.—Finished case of "sevens."

Alternate or Flat Pack.

The bananas are placed singly on their sides as in the concave pack for "sixes" and "sevens." The fruit in the second layer is also placed on its side on top, but between the fruit of the first layer with the curve of the fruit reversed to that of the bottom layer. The third layer is also laid flat and the curve reversed to that of the second layer, and so on, until the case is filled. A very solid pack is thus obtained and as there is not so much "give" as in the concave pack there is not the necessity to secure so great a bulge on the lidded case.

In packing "eights" the fruit is placed in the case in a similar manner to that described for the concave "sixes" and "sevens" pack but no centre bananas will be required. (Fig. 35.)

Fig. 35.—Case of "eights" packed.

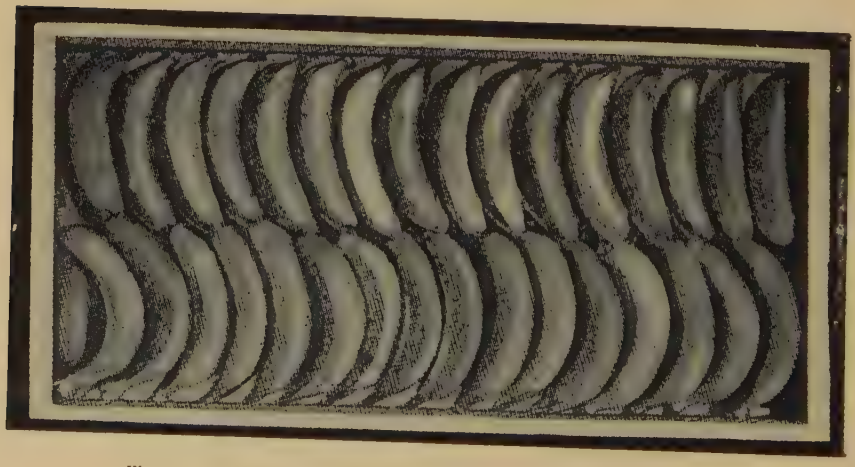


Fig. 36.—Method of placing first layer of large curved "eights."

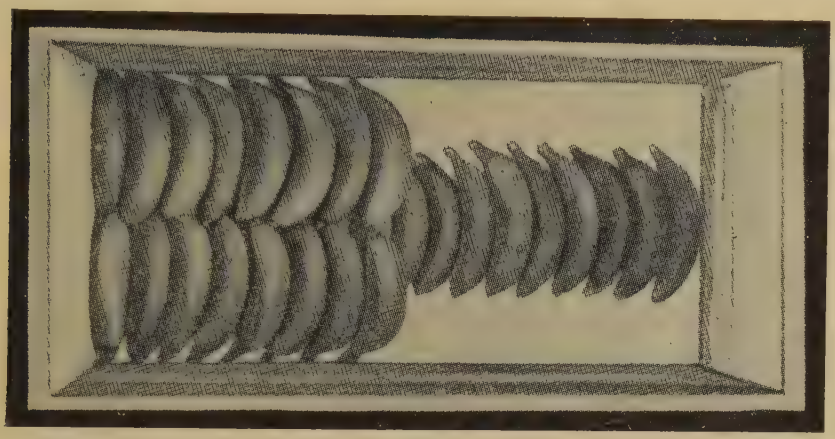


Fig. 37.—Another method of placing first layer of large "eights" and of "nines."

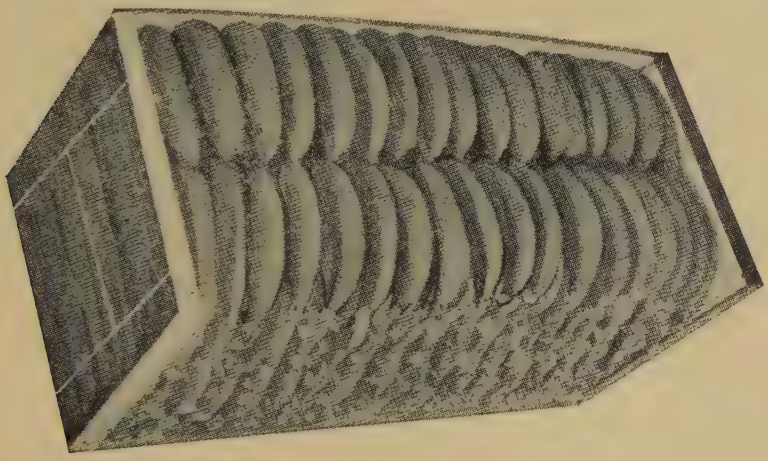


Fig. 38.—Completed case of "nines."

With some lines of "eights," especially with curved fruit, the "S" type pack (Fig. 36) will be found useful. In this pack one row of the bottom layer is placed reverse to the other giving the bottom layer an "S" appearance. The second layer is placed similarly between the first layers but all subsequent layers are placed concave downwards.

With large "eights" and "nines" a layer of fruit is placed down the centre of the case and then the next layer is placed on its side. (Fig. 37.) The layers from thereon are placed concave downwards as in the ordinary concave pack. (Fig. 38.)

To obtain a good solid and attractive pack it is necessary to complete each layer of fruit before commencing the next layer. (Fig. 39 depicts a perfect pack.)

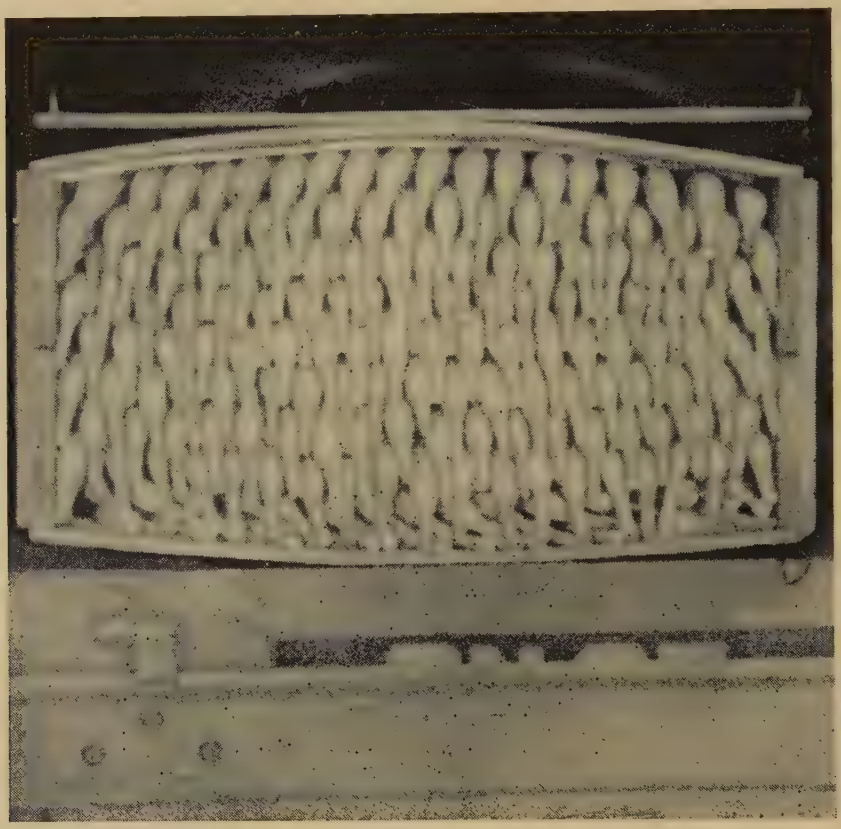


Fig. 39.—Side of case removed showing a perfect banana pack. Note the good even layers and spacing of each fruit in each layer. Also note how bulge is at bottom as well as at top of case.

Nailing Down and Wiring.

It is advisable to place a double fold of clean paper over the top layers of fruit just prior to nailing down as this will assist to avoid skin markings from the top boards.

When nailing down, the case should be placed on two blocks or suitable frame so that when the pressure is applied to the lid the pressure will be more evenly distributed through the contents of the case and part of the bulge will develop on the bottom boards.

The nailing down should be delayed as long as possible and where practicable left until just prior to removal from the packing shed.

A suitable case press or clamp should be used for this work. Do not stand, sit on the lids, or bump the case in order to settle the fruit down. If this operation cannot be handled by the case clamp without resorting to these methods it may indicate that the pack is too high. To avoid marking of the fruit

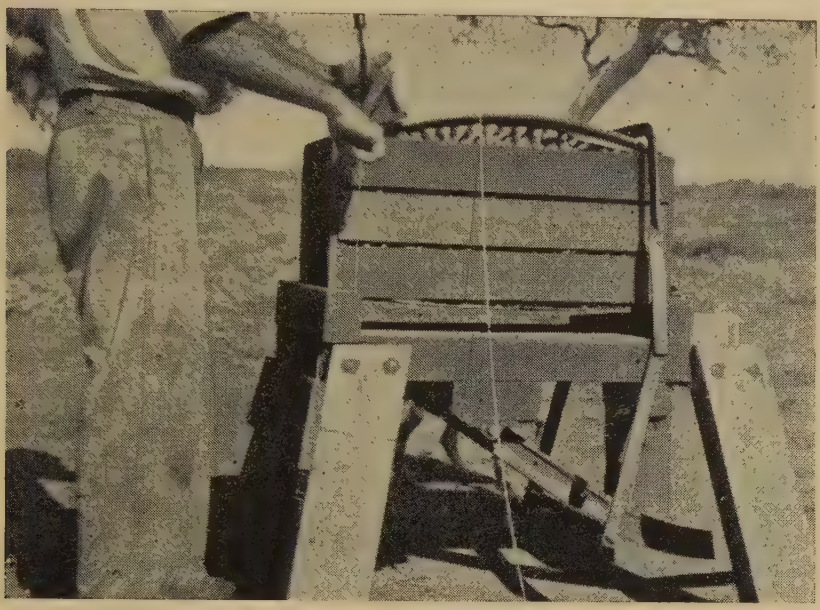


Fig. 40.—Showing correct position to apply:—A. Right hand side—case clamps and pressure. B. Left hand side—wire machine and wire.

shoulders on the side of the case when the case clamp pressure is applied some growers use pieces of tin. These are slipped down between on the insides of the case just prior to applying the case clamp and are then withdrawn once the lid has been nailed down.

The case should be strapped or wired at each end. If wires are used they should be placed about an inch in from the end of the case making sure that the wire is equidistant from the ends of the case and not on an angle before tightening. (Fig. 40.)

Frequently this important job is carelessly attended to, resulting in the wires slipping off as the bulge shrinks and eventually the lid bursts and spills the contents. Actually the wiring of the case is one of the most important operations for the wire acts as the growers final insurance of safe transport to market. The case should always be laid on its side when wiring or strapping.

Finally, neatly stencil the case, always stack on the flat, never walk on packed cases and keep the fruit cool while awaiting transport.

State Agricultural Education.

W. SOUTHERN, Principal Muresk Agricultural College.

Considerable doubt appears to exist as the functions of the three State-controlled educational institutions which are concerned with agricultural training and a short review of them will be of assistance to farmers and others who are interested in the training of their sons for agricultural pursuits.

The institutions are:—

(a) Narrogin School of Agriculture, Narrogin, W.A.

(b) Denmark School of Agriculture, Denmark, W.A.

(c) Muresk Agricultural College, Muresk, W.A.

The first two are controlled by the Education Department. They are of similar standard. The courses are adapted to the work carried out in each district. The Denmark school for instance, gives a good deal of attention to dairying.

The standard of education may be regarded as post-primary. Students who are aged 14-17 years are eligible for admission provided they have passed the sixth standard.

The schools afford boys from rural districts greater facilities for education, particularly along lines which will be of most value to them as primary producers. Students are given a general education and, at the same time, have the opportunity of acquiring technical skill and knowledge in handicrafts. Other subjects such as bookkeeping are also taught. Special attention is given to harness repairing, blacksmithing and carpentry.

The course is of two years duration and approximately half of that time is spent in outdoor work. Students thus secure practical instruction in various branches of agriculture.

Applications for admission must be sent to the Education Department by a fixed date each year and are invited through advertisement in the Press. A Selection Committee considers them and successful students are notified.

When applications exceed the vacancies, preference is given to the sons of farmers.

Students must be physically fitted for farm work.

The annual fee is £42 5s.

Full details including information concerning free scholarship and living away from home allowance paid to those seeking specialised education at these two schools, may be secured from the Education Department, Perth.

Muresk Agricultural College is the senior school in standard. It is this State's counterpart of Hawkesbury, Dookie and Roseworthy Agricultural Colleges and is controlled by the Department of Agriculture.

Those who desire to apply for admission must, before entering the college, have attained Junior Certificate standard. Applications close on 31st December, and the success of them is announced immediately after the Junior Certificate results are released.

Those who are competing for an Agricultural Diploma Scholarship must forward their completed application by November 30th. They must also apply for marks when entering for the Junior Certificate examination.

The certificate results are not the only means by which students are selected. It must be remembered that students in country centres may not have the opportunity to cover a large range of subjects. English and mathematics may be regarded as important. Other factors such as general interests are taken into account. It can also be anticipated that those with rural interests have a strong claim.

Students must be physically fit.

Two full time courses are normally conducted:—

(a) Diploma in Agriculture.

(b) Diploma in Dairy Science.

(a) Is a three year general course in Agriculture.

The situation of the College (three miles south of Spencer's Brook) allows most types of farming operations to be carried out. Among its activities are the growing of grain, fodder and pasture crops, dairying, pig and poultry raising, orcharding, etc. Instruction in building construction, woolclassing, blacksmithing, gardening, etc., is given.

The work is arranged so that practical work and class work are held in alternate weeks. The class courses include a wide range of subjects such as veterinary science, animal husbandry, mechanics, farm management, bookkeeping and others.

Applicants who have attained a higher standard than the Junior Certificate may be admitted to the second year of the three year course, provided that vacancies exist. Such applicants should at least have a knowledge of chemistry and physics. They are judged on their merits as well as their knowledge of the first year work.

(b) Is a course of two years and is designed to train students for employment in dairy factory work.

Application conditions, similar to those for the agricultural course apply. Holders of the Muresk Diploma in Agriculture or those who have had satisfactory factory experience and have attained a suitable educational standard, may be exempted from the first year of the course.

The Annual Fee for either course is £61 per annum.

Generally speaking, students are entitled to the living away from home allowance of £30 per annum. This allowance is paid by the Education Department.

Secondary School scholarship holders and those who gained "admissions" to Government High Schools may have their scholarship or "admission" continued at Muresk.

The following scholarships are available each year:—

(a) *Diploma of Agriculture.*

(1) "Western Mail" Scholarship, restricted to sons of primary producers.

(2) Three Department of Agriculture Scholarships

Each scholarship is of £50 annually, for three years.

(b) *Diploma in Dairy Science.*

A scholarship of the same value may be awarded to a student who has been granted first year exemption.

A special examination is held in order to assist in the selection of the holder.

The scholarships will not be awarded unless students of sufficient merit present themselves.

Full details, including scholarship applications, concerning the College may be secured from the Principal at Muresk, W.A. or the Department of Agriculture, Perth.

Field Days.

FIELD days are effective in bringing farmers together with a view to their gaining information regarding their problems either from an inspection of what other farmers are doing, from informal discussions, or from lecturettes and demonstrations.

The arrangement of these meetings in a farming atmosphere tends to dissipate any reserve and helps, through the informality of the proceedings, to allow all to feel as if they are contributing to the day.

The function may be carried out in one of several ways. One or two departmental officers may guide the party on its inspections and lead the discussions, or the farmers may prefer to inspect a larger number of activities with the minimum of discussion.

A group listening to a lecturette.

On some occasions a number of farms may be visited on the one day. These days serve to advertise a district and to show what individual farmers have done in overcoming their problems. The inspections are usually amplified by the various farmers describing their methods with or without explanations of principles by the leader.

It appears, however, that the most useful days are those which are arranged to allow a number of short talks by men specially qualified and who are prepared to answer questions and to stimulate discussion.

The Department of Agriculture is anxious to encourage the organisation of these days as it is realised that they are useful in extending information. It is the function of the department to help and guide the farmer with the best information regarding the practice and principles of his particular type of farming. Therefore it is anxious that Field Days be arranged as a regular feature in all districts and frequently undertakes the necessary preparations.

How to arrange a Field Day.

The first step is for some local organisation to decide that it desires a Field Day to be held to demonstrate some particular aspect of farming.

A date or dates should be determined tentatively while a decision is necessary also regarding the location of the proposed function.

A letter should then be forwarded to the Department of Agriculture stating that a Field Day is wanted at the selected place and time. An indication should also be given of the main topics it is desired should be discussed.

It is wise to enlist the aid of the district officer who, if unable to assist directly in the preparations, may be able to guide the organisers. He may be in a position to finalise arrangements on behalf of the local body, so that the appropriate officers may be in attendance.

Informality in proceedings is the key-note.

A local farmer should be appointed to act as chairman to arrange for the welcome of visitors and the announcement of the programme and other features. If the function is to commence in the morning provision should be made for light luncheon or for hot water and shelter for picnic parties. Frequently bodies such as the Red Cross or the Country Women's Associations will look after the catering arrangements.

Organisation on the Appointed Day.

As the success of the gathering will depend largely on its informal character, the most convenient assembly point for visitors should be chosen. From there the introduction of the leaders for the day takes place, and from that point the direction of the proceedings may continue with a local representative or be given to an officer.

Before this stage is reached, however, a discussion between the local organisers, the farmers owning the property and the officers will have determined the programme.

Naturally the best scheme is to have a property on which the various phases of farming to be discussed are well represented and the assembly moves from point to point so that each talk is given in the proper atmosphere. For example a talk on the herd sire would take place after an inspection of the bull—or a discussion on sheep would develop during an inspection of the flock or of the sheep yards and dip. Pig raising would be the subject for consideration during an examination of the brood sows and the boar and their accommodation.

In this way interest is maintained as the gathering does not tire from standing or sitting in one place. There are short breaks between lecturettes for examination of premises or stock, or during the walk to the next point.

The aid of women's organisations make for a successful day.

A careful arrangement of the order of lecturettes and so also of the route of inspection to diversify the programme is useful. For example it is advisable to discuss the herd, dairy premises, the bull, calf feeding, not one immediately after the other, but interspersed with other topics, e.g., pastures, stock diseases, water supplies, general surveys of the various industries.

A number of speakers also stimulates interest providing any one is not expected to take too many periods in a short space of time.

Talks should be short and directed as far as possible on aspects of farming illustrated on the property. They should be of such a nature that they stimulate questions from the listeners. Speakers should complete their remarks well within their time allowance so that there will be time for a discussion.

Catering plays an important part in the day's activity.

Illustrations of programmes of field days in the dairying areas are given hereunder.

	a.m.	
I.	11.0	Assembly.
		Introduction by chairman.
		Reply by senior officer A with outline of programme.
	11.10	Dairy Premises Officer B.
	11.30	Pasture establishment and species—Officer C.
	11.50	Dairy Herd—Officer A.
	p.m.	
	12.10	Diseases of Cattle—Officer D.
	12.30	Lunch.
	1.15	Survey of present position Dairying Industry—Officer A.
	1.40	Dairy Hygiene—Officer B.
	2.5	Pasture Management, Hay and Silage Making—Officer C.
	2.30	Diseases of Pigs—Officer D.
	3.0	Pig Raising—Officer A.
	3.20	Herd Recording—Officer C.
	3.45	Questions, General—All Officers.
	4.0	Afternoon Tea—Disperse.
	a.m.	
II.	11.0	Assembly and introduction by chairman.
		Reply by Senior Officer with outline of programme.
	11.10	Farm Water Supplies.
	11.30	Bulls—Selection of and Management.
	11.50	Pastures Establishment and Management.
	p.m.	
	12.15	Machinery Demonstration.
	12.40	Lunch.

p.m.

1.30 Irrigation.
1.50 Cattle Diseases.
2.15 Feeds and Feeding.
3.5 Pigs.
3.25 Fertiliser Problems.
3.45 General Questions.
4.0 Afternoon Tea and Disperse.

III. In mixed farming areas other topics than dairying can be included, i.e.:-

a.m.

11.0 Assembly—Introduction, etc.
11.10 Inspection of Premises and Talks.
Dairy—Sheep Yards and Shearing Shed.
11.40 Pasture Establishment and Management.

p.m.

12.0 Management of Sheep and Fat Lambs.
12.20 Dairy Hygiene.
12.40 Lunch.
1.25 The Dairy Herd and Herd Sire—Selection and Management.
1.50 The Vegetable Garden.
2.10 Fodder Conservation.
2.30 Hay Baling Demonstration.
3.0 Cattle and Sheep and Pig Diseases.
3.30 Pig Raising.
3.45 Question Time.
4.0 Afternoon Tea and Disperse.

Summary.

a. Field days must be informal.

b. They should be organised to allow movement to inspect various features of the farm.

c. Speakers should be as numerous as can conveniently be arranged.

d. Talks should be short and simple.

e. Talks should be related to practical and topical problems.

f. Questions and discussion should be encouraged.

Various Means of Distribution of Water on the Dairy Farm.

J. T. McNALLY, Dairy Adviser.

THE necessity for a continuous supply of water at the dairy premises has been more forcibly brought to the notice of dairy farmers since the economic value of milking machines has been recognised and the installation of these plants has become so popular.

For the successful dairy man adequate water supplies with efficient means for economical distribution are of the utmost importance, therefore, every dairy should possess equipment that will provide this essential need.

The most economical source of water supply is the storage of rain-water from the sheds and buildings. Unfortunately, this usually consists of a small galvanised iron rain-water tank connected to the dairy sheds which is purely dependent on the quantity and continuity of rain to supply sufficient water. This is satisfactory during the wet winter months but as the spring advances there is a tendency to ease up on the use of the stored water and the dairy hygiene deteriorates accordingly.

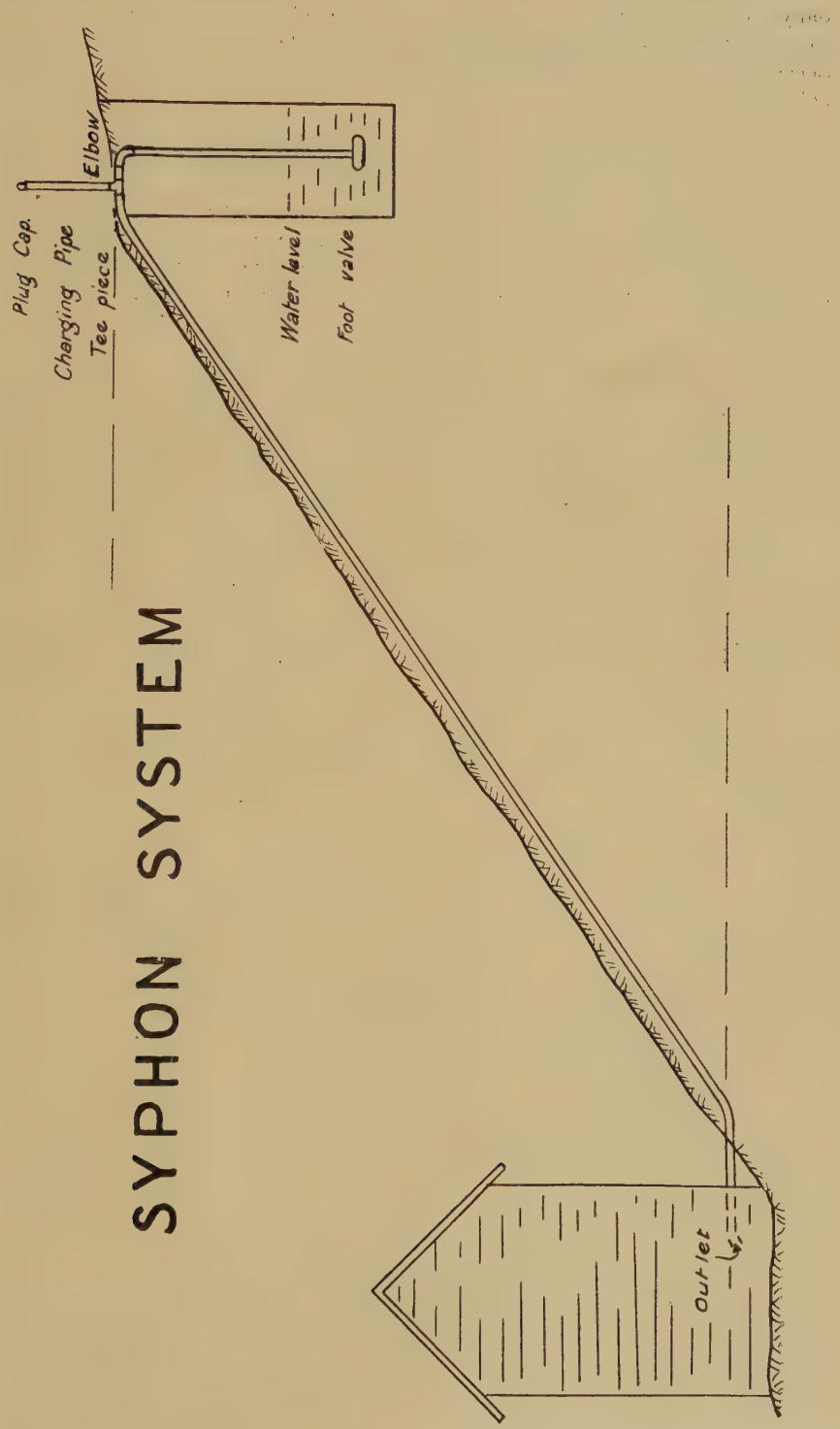
To take full advantage of the annual rainfall adequate storage is essential. In this connection the large concrete brick circular tank usually from 6,000 to 10,000 gallons capacity, if built correctly, is very satisfactory and holds sufficient water for the average dairy for a considerable time. The cost varies according to the availability of materials. In some districts tanks have been built at a total cost of from £35 to £60. The main essential in constructing this type of storage tank is to have solid foundations, clean materials and a knowledge of concrete construction. The average farmer should employ a tradesman well versed in this work, as a sound job pays dividends.

In hilly districts some excellent supplies of water have been found on the higher reaches of the hills above the dairy premises. Where the surface of the water is above the dairy level and yet below the ground level at the well, a syphon can be successfully used to supplement the storage tank or be used direct.

In installing this system several points are essential for successful results.

1. The level of water in the well must be above the point of delivery, the greater the vertical distance the more efficient the delivery.
2. All joints, pipes and fittings must be pressure tight.
3. Keep inlet pipe well below surface of water.
4. An air lock can be caused by the heat of the sun releasing gases in the water, which rise to the highest point in the pipe line. This occurs most frequently in systems which are not in constant use. It is advisable to place pipes underground as a guard against this possible trouble.

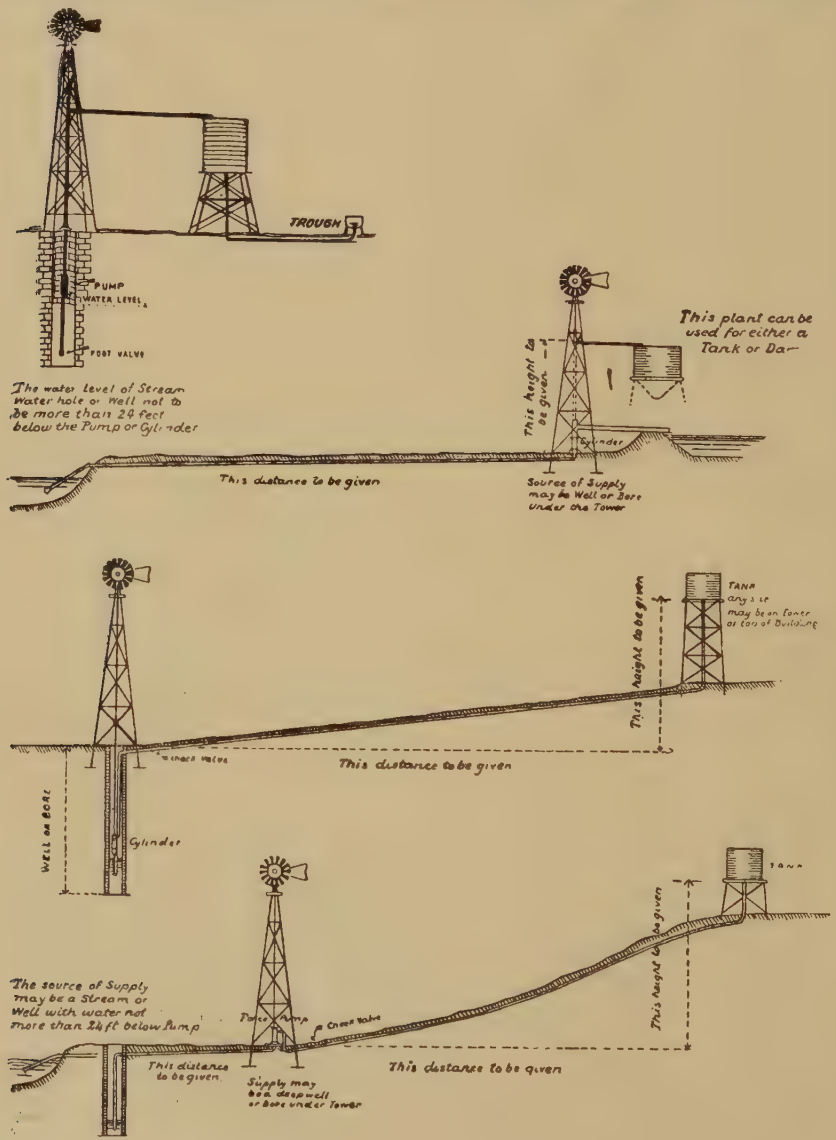
The pipe leading from the well should be fitted with a foot valve and strainer and a tee piece inserted alongside the elbow fitted at the surface of the ground. To this tee piece a suitable length of pipe can be connected verti-


SYPHON SYSTEM
Plug Cap.
Charging Pipe
Tee piece
Elbow
Water level
Foot valve
Outlet

cally, through which the whole system can be filled with water, then plugged up and if gas tight, water will be available at the point of delivery. On rare occasions when an air lock occurs it is rectified by unscrewing the plug and refilling the pipe.

The plan on page 149 gives an outline of the system operating on a farm in the South-West.

On a number of hillsides springs and soaks have been found to exist. These are a valuable source of supply and if above the dairy premises can be economically brought into use by sinking a wooden or concrete box at the point of outlet of the water, protecting it from stock and connecting to the dairy with


TROUGH
PUMP
WATER LEVEL
FOOT VALVE
The water level of Stream water hole or well not to be more than 24 feet below the Pump or Cylinder
This distance to be given
This height to be given
This plant can be used for either a Tank or Dam
Cylinder
Source of Supply may be Well or Bore under the Tower
TANK any size may be on tower or top of Building
This height to be given
This distance to be given
Well or Bore
Cylinder
The source of Supply may be a Stream or Well with water not more than 24 ft below Pump
Force Pump
This distance to be given
Supply may be a deep well or Bore under Tower
This distance to be given
This height to be given
TANK

piping. As an alternative a tank can be placed just below the soak, or near the point of delivery, as a reservoir and then connected with the dairy. This has the added advantage of creating a reasonable force and is adaptable for hosing.

Wells and bores are a very valuable source of supply of water. Various methods are in use for raising the water, varying from the bucket and rope to the power driven pump. Any system which entails manpower is usually irksome, is used only when absolutely necessary, and then to a minimum extent. The semi-rotary and Douglas pumps are efficient and if manpower is available can be effectively utilised.

With water available in bores, wells, dams, still water streams, fast or slow moving streams the windmill has proved very efficient. This economical means of water pumping has been used for many years and modern engineering has improved it so that few other methods can compare with it. For best results the mill should be high enough and the surrounding country sufficiently clear to allow full use of prevailing winds. In the accompanying diagram various layouts for windmills are demonstrated showing the adaptability of this equipment.

Windmill Capacities.

The figures given below are based on a wind velocity of 12 to 15 miles per hour, and with speed regulators, with which well known mills are fitted, set to give the number of strokes per minute shown on table. It should be understood that the proposed mill site is one favourable for wind.

Table showing approximate capacities (per hour) of well known windmills working against different heads and also showing size of pump recommended for each head.

Size of Mill and Pattern.	Length of Stroke.	No. of Strokes per min.	Total Head in Feet.				
				25.	50.	75.	100.
6 ft. Single Crank ...	6½ in.	30	Pump Cap	2½ in. 175	2 in. 115	1½ in. 65	... ...
8 ft. Single Crank ...	6½ in.	30	Pump Cap	2½ in. 200	2½ in. 175	2 in. 115	... ...
6 ft. Planetary Crank	5½ in.	30	Pump Cap	2½ in. 140	2 in. 100	2 in. 90	... ...
8 ft. Planetary Crank	5½ in.	25	Pump Cap	3 in. 170	2½ in. 120	2 in. 90	2 in. 75
10 ft. Planetary Crank	6½ in.	22	Pump Cap	4 in. 330	3½ in. 250	3 in. 185	2½ in. 140
8 ft. D. Geared Crank	6 in.	30	Pump Cap	3½ in. 320	3 in. 200	2½ in. 160	2 in. 120
10 ft. D. Geared Crank	7 in.	25	Pump Cap	4 in. 400	3½ in. 310	3 in. 225	2½ in. 180

For areas where the use of the windmill is not suitable, the power driven pump can be adapted to give excellent results. There are a number of different types of pumps, but where the water supply is adequate and conditions suitable, the centrifugal pump is recommended.

The efficiency of this pump is based on the size and speed of the impeller, the suction head, and the distance from the source of supply. One of the main features of installing a centrifugal pump is to place it as near to the water as practicable and never more than 15 ft. vertical distance. The delivery pipe should be the next size larger than the pump outlet to reduce friction. All joints including the stuffing box on pump should be air tight and the pump driven at the number of revolutions recommended by the manufacturers.

Various sources of power can be utilised, such as a direct coupled electric motor, belt driven from a stationary engine or a mobile engine such as is used for a power saw. When considering installing a unit of this description, give full particulars to your supplier and follow the advice of the experts who are generally available for guidance in these matters.

However, the accompanying table will give the approximate particulars of power required, revolutions and the capacity per hour. The head refers to the vertical height from the source of supply to the delivery plus friction from the pipe line.

Approximate Table of revolutions per minute and horse power required when using Ball-Bearing Centrifugal Pumps against total heads of 10 to 100 ft. at rated capacity—Gallons per Hour.

SINGLE STAGE 1½ IN. PUMP STANDARD TABLE.

Revs.	Head.	Gallons.	B.H.P.
1,330	10	2,200	·5
1,475	20	2,200	·6
1790	30	2,200	·75
2,040	40	2,200	·9
2,275	50	2,200	1·2
2,300	30	4,100	2
2,300	40	3,600	1·75
2,300	50	2,880	1·75
2,300	60	2,200	1·5
2,850	50	4,800	3·3
2,850	60	4,100	3·1
2,850	70	3,200	3
2,850	80	2,880	2·4
2,850	90	1,440	2
3,400	60	5,000	5
3,400	70	5,000	5
3,400	80	4,800	5·25
3,400	90	3,600	5·24
3,400	100	2,880	4·75
3,400	110	2,400	4

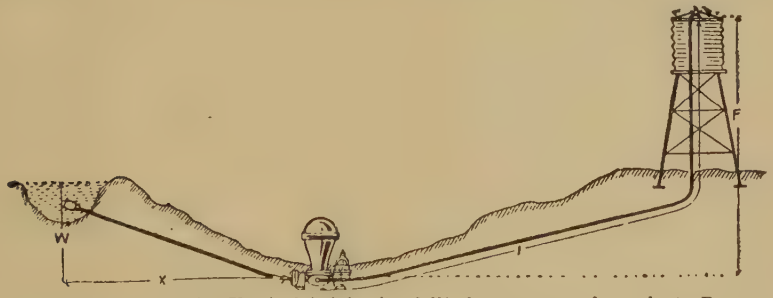
SINGLE STAGE 2 IN. PUMP STANDARD TABLE.

1,100	10	3,300	1
1,250	20	3,300	1·1
1,420	30	3,300	1·5
1,610	40	3,300	2
1,780	50	3,300	2·4
1,975	60	3,300	3·1
2,100	70	3,300	3·9
2,200	50	7,500	5·5
2,200	60	7,200	5·25
2,200	70	6,000	5
2,200	80	4,100	5
2,200	90	2,100	4

TWO STAGE 1½ IN. PUMP STANDARD TABLE.

2,560	...	...	...	20	5,760	4·5
2,560	...	...	...	30	5,000	4·1
2,560	...	...	...	40	4,700	4
2,560	...	...	...	50	4,100	3·8
2,560	...	...	...	60	3,900	3·7
2,560	...	...	...	70	3,600	3·6
2,560	...	...	...	80	3,200	3·4
2,560	...	...	...	90	2,600	3·25
2,560	...		...	100	2,400	3
2,560	...	...	...	110	1,800	3
2,560	...	...	...	120	1,320	2·7
2,750	...	...	...	50	5,000	5
2,750	...	...	...	70	4,250	4·5
2,750	...	...	...	100	3,600	4·25
2,750	...	...	...	110	3,000	4·5
2,750	...	...	...	130	2,500	4·25
2,750	...	...	...	140	1,500	4·25
2,750	...	...	...	150	1,720	6
3,150	...	...	...	100	4,800	6·5
3,150	...	...	...	110	4,100	6·25
3,150	...	...	...	120	3,600	6
3,150	...	...	...	130	3,200	6
3,150	...	...	...	140	3,000	6
3,150	...	...	...	150	2,880	6
3,150	...	...	...	160	2,040	6·5

Where farms are situated adjacent to running streams one of the simplest units for getting the water to a height considerably above the source of supply is the hydraulic ram. This is a self acting pump which utilises the momentum of a slight fall to elevate water many times the height of the fall used to operate the unit.



Hydraulic Ram. W—Vertical height (or fall) from source of supply to Ram. X—Distance in which fall is obtained. F.—Vertical height from Ram to point of discharge.

The hydraulic ram must be set below the level of the supply. The water acquires a constantly increasing velocity in its downward course from the supply to the ram until it is suddenly stopped by the closing of the impetus valve. Its only chance for escape is through the inside valve, which opens into the air chamber; the air in this chamber is compressed by the blow sufficiently to allow a portion of the water to enter.

The air immediately expands and recovers again its original volume. This action closes the inside valve and compels the excess of water to escape through the discharge pipe which has now become the only means of exit.

Up to 90 per cent. of the water runs to waste through the impetus valve.

When the impetus valve rebounds, the water in the drive-pipe is again allowed to acquire velocity by washing around the valve, the friction of the water again raises the valve and the process is continued as before.

The fall, or vertical distance from the surface of water in the supply reservoir to drive opening in the ram, must be not less than two feet (as this is the lowest head under which a ram will work satisfactorily.

The discharge elevation, must be not less than six times nor more than twelve times the fall. Should the discharge elevation be less than six times the fall, this condition may be corrected by installing a valve in the line and throttling it so as to produce the required back pressure by restriction. The drive or supply pipe should be placed at an angle of not more than thirty degrees to give the best results and as a general rule the length should not be less than three-quarters of the height to which the water has to be raised. The length may, however, be much greater than this where it is necessary in locating the ram to obtain the desired amount of fall.

The table below will give the approximate efficiency of the hydraulic ram.

TABLE SHOWING APPROXIMATE EFFICIENCY OF WELL KNOWN HYDRAULIC RAMS.

Minimum fall of water, in feet, under which ram will effectively elevate water to height given below	2	2	2	3	4	5	6	7	8	10	12	15
Height in feet, the water may be elevated	4	6	8	15	24	35	48	63	80	100	120	150
Length of drive pipe, in feet ...	12	12	12	15	20	30	40	50	60	75	95	110
Number of times the height or elevation of discharge is greater than the fall	2	3	4	5	6	7	8	9	10	10	10	10
Proportion of water elevated or discharged by the ram ...	2/7	1/5	1/7	2/17	1/10	1/12	1/14	2/31	1/17	1/18	1/20	1/25
Proportion of water wasted at the impetus valve by the ram ...	5/7	4/5	6/7	15/17	9/10	11/12	13/14	29/31	16/17	17/18	19/20	24/25
Per cent. of useful effect of power expended	80	78	75	72	68	62	57	53	48	43	38	35

In compiling this article an endeavour has been made to bring before dairymen generally an easy and efficient method of making available at the dairy premises sufficient water for the carrying out of the required routine in keeping the plant in an hygienic condition. Not only is sufficient water available for this purpose, but, on most holdings, the source of supply is ample to allow an efficient cream or milk cooling system to be installed, which is essential for a high quality product, and also give a reasonable surplus for stock.

ACKNOWLEDGMENTS.

Thanks are expressed to Messrs C. George and Walter Wilson for assistance in compiling this article.

1947 Grasshopper Conference.

By C. F. H. JENKINS, Government Entomologist.

INTRODUCTION.

THE most serious grasshopper outbreak in the history of Western Australia occurred in 1937 when widespread damage was done in many parts of the outer wheatbelt and the pest encroached into some of the older established agricultural districts.

In subsequent years, the severity of grasshopper plagues has fluctuated with seasonal conditions but the pest is regarded as one of the most serious threats to agriculture in the lighter rainfall areas.

In 1942 the then Minister for Agriculture (Mr. F. J. S. Wise) convened a Conference of farmers' representatives and Government Officers to discuss the "Rehabilitation of the Marginal Areas with Particular Attention to the Grasshopper Menace." A comprehensive report was submitted dealing with all aspects of marginal area rehabilitation and setting out a long term policy for grasshopper control.

Typical grasshopper country, north-eastern wheat belt.

The 1947 Conference was arranged to review the findings and results of the earlier Conference and to make additional recommendations considered advisable.

The gathering comprised officers of the Rural and Industries Bank, Department of Agriculture and farmers' representatives and was opened by the Under Secretary for Agriculture (Mr. G. K. Baron Hay) on February 26th.

Distribution of grasshopper swarms in 1937.

GRASSHOPPER OUTBREAKS SINCE 1942.

In reviewing grasshopper outbreaks since the last Conference held in 1942, it was stated that, although the insects had been numerous and widely scattered during several seasons, no widespread damage has been done and that the past control policy had played an important part in bringing about this satisfactory state of affairs. It was announced that, during the last five years over £36,000 had been expended by the Government on control measures and that under the scheme approximately 217,000 acres on occupied and reverted holdings had been broken up to prevent the hatching of grasshopper eggs.

Hatched egg-pod of the small plague grasshopper showing soil cap and moulted "skins" of nymphs.
(After A. D. Cocks.)

Delegates were agreed that the extensive ploughing operations carried out in the past 10 years had greatly assisted in preventing major grasshopper outbreaks in the outer wheatbelt. In connection with grasshopper ploughing in recent years, it was pointed out by Mr. Austen (Rural & Industries Bank) that the proportion of reverted to occupied holdings had diminished greatly in the last year or so because under the recent reconstruction policy, many previously abandoned holdings had been linked to neighbouring occupied farms.

CHIEF RECOMMENDATIONS DISCUSSED.

(a) *Central Representative Advisory Committee.*

Delegates considered that periodic meetings of such a Committee would be very beneficial.

No set meeting times were specified as it was felt that these could best be left to the discretion of the Department of Agriculture.

(b) *District Advisory Committees.*

Although certain District Committees had shown little interest in assisting in grasshopper control, it was considered that in many areas these committees served a very useful function and that an effort should be made to stimulate the work of these bodies in the future.

To this end, it was suggested that the Secretary of each Road Board concerned should arrange meetings between the District Advisory Committee and the Rural & Industries Bank Inspector in order that the plotting of infested areas might be discussed as well as other problems.

It was also considered very essential that officers of the Entomological Branch should keep in personal touch with the District Committees and that occasionally combined meetings of these Committees should be called at suitable country centres and that an Entomologist should attend.

The small plague grasshopper.
(After A. D. Cocks.)

(c) *Division of Wheatbelt into Zones A, B, C, according to liability of Grasshopper Attack.*

Zone A. Unaffected or lightly affected established farming localities in the north-eastern districts west of the badly affected areas.

Zone B. The area between Zone A and a line parallel to and five miles east of the Rural & Industries Bank's marginal line, the width of this zone varying from 10 to 25 miles.

Zone C. The area east of Zone B to the limit of development for farming purposes.

The foregoing zones as defined by the 1942 Conference were approved after some discussion as to whether a portion of Zone C could be added to Zone B.

(d) *Ploughing of Breeding Grounds.*

The cultivation of breeding grounds to be commenced in Zone B and extended to Zone A and C to the extent to which funds, equipment and manpower will permit.

This was agreed to in principle and will be discussed in greater detail under the heading of *Future Control Measures.*

(e) *Poison Operations.*

These to be supervised by the Department of Agriculture and local authorities.

The farmers' representatives spoke strongly concerning the effectiveness of poisoned bait and considered that it should be more widely used especially to deal with isolated outbreaks and on country not suited to cultivation.

(f) *Control of Operations.*

The Rural & Industries Bank with the assistance of the Department of Agriculture to control the field operations against the grasshopper.

It was considered that this system had worked very satisfactorily but that there should be more field work done by entomologists.

(g) *Experimental Work.*

For a number of years efforts have been made by the Department of Agriculture to discover suitable pastures which would render unnecessary the repeated cropping of areas of the outer marginal districts where properties are used for stock only.

The Chairman announced that investigations along similar lines were being carried out in South Australia where a grasshopper problem existed very similar to our own. He stated that he had visited much of the area in question in 1945 and had discussed all aspects of control with Entomologists and Agrostologists of the Waite Agricultural Research Institute. Mr. Thomas (Department of Agriculture) stated that while little progress had been made in developing anything in the nature of a permanent pasture for the dry wheat area, very promising results had been obtained with Greenough Barley and Wimmera Rye, both very early maturing varieties. Seed was at present in short supply but this was being bulked at the Research Stations.

Power driven bait-mixer used at Narembeen in 1936.

FUTURE CONTROL MEASURES.

Ploughing. Recommended that Government assistance be continued for ploughing on unoccupied and on occupied holdings.

Reverted Holdings.—Ploughing to be done by contract as in the past.

Occupied Holdings. (a) Government assistance to apply only to grasshopper ploughing done in excess of the normal fallow.

(b) Farmers to be required to adhere to a five years rotation as set out hereunder. This would ensure that all cultivable land is broken up every three years.

Five Year Rotation.

Fallow.
Wheat.
Oats and Wimmera Rye.
Pasture.
Pasture.

Super spreader adapted for bait distribution.

(c) Subsidy to be available annually until all cultivable land on the farm has been broken up under the rotation. It was considered that the area would then be free from grasshoppers and that the responsibility to continue and finance the rotation should then rest with the farmer.

Summer Ploughing. It was decided that summer ploughing should be recommended in those areas where it was considered practicable by the district Rural Bank Inspector or other responsible officer.

Poison Baiting. It was recommended that an endeavour should be made to stimulate the use of poison bait by circulating Road Boards and pointing out the necessity of controlling isolated outbreaks on land unsuitable for cultivation. In some cases the neglect of such areas led to the re-infestation of adjacent ploughed land.

Plotting of Egg Laying Areas. It was recommended that:—

(a) The present system of plotting egg laying areas be continued, the infested areas to be plotted as accurately as possible.

(b) The Rural Bank Inspector and the District Advisory Committee confer before submitting the final map so that the relative importance of various breeding grounds could be discussed.

(c) An Entomologist be available in the field during the main egg laying period.

Research. It was recommended that:—

(a) Experiments be continued with the new insecticides D.D.T. and 666 both for baiting and spraying.

(b) That inquiries be made from the R.A.A.F. regarding the availability of planes and trained personnel in this State equipped to undertake aerial spraying.

(c) The whole subject of aerial spaying to be thoroughly investigated to determine whether it would be applicable under local conditions.

Bathurst Burr.

A SERIOUS NOXIOUS WEED.

C. A. Gardner, Government Botanist.

G. R. W. Meadly, Weeds Officer.

RECENT reports of Bathurst burr from Narembeen, Donnybrook and Midland Junction draw attention to the ever present risk of this serious weed becoming established in the agricultural areas of Western Australia. Bathurst burr first appeared at Twofold Bay in New South Wales in the forties of last century, being introduced to Australia in the tails of horses imported from Valparaiso, South America. A few years later it was reported from Bathurst and since has spread over a large area in New South Wales, besides becoming a serious weed in other States. In Western Australia, the main areas of infestation are located in the Eastern Goldfields district, centred on Kalgoorlie and Coolgardie while restricted occurrences have been reported from a number of places ranging from Geraldton to Albany including the Metropolitan area.

Bathurst Burr (*Xanthium spinosum* L.).
Explanation of Plate.
A—Portion of branch with lateral branchlets. B—Young leaf and spines.
C—Fruit or "burr."

Although Bathurst burr is well known to farmers and pastoralists in the Eastern States, it is not as readily recognised by the man on the land in Western Australia owing to its limited occurrence in this State. The accompanying drawing will assist greatly in the recognition of this weed. It is a rigid, much-branched annual of 1 to 2 feet in height with greenish-yellow stems which bear leaves that are dark green above but pale underneath. These leaves are usually three lobed with the central lobe longer than the other two and bear at their bases rigid three pronged spines. The flowers are inconspicuous and are succeeded by brown egg-shaped burrs of about one half inch in length. These are covered with fine hooked bristles along with two short straight horns at the apex. The plant is essentially a summer-growing annual but seeds germinate and plants mature out of season, thus adding to the difficulties of control.

Losses caused by Bathurst Burr.

There is some evidence to indicate that Bathurst burr is harmful to stock at certain stages of growth but the spiny nature of the plant renders it unattractive and it is seldom eaten. The characteristic which has made it such an undesirable weed is the tenacious nature of the burrs. These readily become attached to clothing, bags and farm animals, especially sheep and when thoroughly entangled their removal is not a simple matter. From a commercial viewpoint sheep present the greatest problem as their fleeces provide a very receptive surface for the hooked burrs. When the weed is abundant the burrs become massed in the wool thus depreciating its value, as contaminated wool requires special treatment following scouring. The direct and indirect loss to Australia amounts to many thousands of pounds annually.

Bathurst burr presents a major problem in Europe, Asia, Africa, America and Australia. Such a situation does not come about by chance and it is interesting to examine the characteristics of the plant which are conducive to its prominence as a weed in many countries. Firstly, it is not unduly limited by climatic requirements and has the capacity to develop from a seedling to a seed bearing plant in a few weeks; secondly the two seeds in each fruit are capable of retaining their viability for long periods, although if conditions are favourable one usually germinates in the first season and the other remains dormant for an indefinite period; and thirdly the hooked appendages could scarcely be improved as a medium for assisting distribution.

Much has been written concerning the efficiency of the Cossack cavalry but they played another role at the beginning of the nineteenth century as indicated by the following description of the spread of Bathurst burr through Europe from the East—"In 1828 it was brought into Rumania by the Cossack horses whose manes and tails were covered with the burrs. It travelled in Hungarian wool, and in cattle from the same country to Regensburg, and on to Hamburg, appearing here and there on the way."

Legislation.

As already mentioned, with the exception of isolated occurrences in the agricultural districts, in this State Bathurst burr is limited to the Eastern Goldfields area. Sites from which the weed has been reported are inspected at appropriate intervals and regulations have been made under the Noxious Weeds Act to control the movement of stock from the main infested areas in order to reduce the chances of spreading to a minimum. Stock, especially sheep, imported from the Eastern States have been responsible for most of the outbreaks in this State and in consequence it is now necessary unless a special permit is secured,

to shear all imported sheep immediately prior to or after arrival in this State. Burrs present are usually removed with the fleece and any remaining are easier to detect in the short wool.

Methods of Distribution.

Although we can attribute most of the occurrences to burrs carried by animals our own experiences have proved that this is by no means the only way in which Bathurst burr is distributed. Agricultural seeds have always presented a ready medium for the dissemination of weed seeds but as the seeds of Bathurst burr remain enclosed in comparatively large fruits the risk of their remaining in crop seeds would appear to be small. This is essentially true but during machining the hooked spines are removed and the smooth fruits containing seeds have been found in large agricultural seed such as Sudan grass.

On one occasion a single plant was found growing in a market garden at Wanneroo. There is every reason to believe this was introduced along with some blood and bone—not in the fertiliser itself but attached to the bag. There is little or no chance of a burr surviving the drying and crushing treatments involved in the preparation of blood and bone, but there is a chance of an odd burr becoming attached to a bag while at the abattoirs.

The possibility of the unusual must always be considered in the case of this and similar burrs. Unwittingly some commercial enterprises have spread this weed in a novel but at the same time most harmful manner. Firms have advertised their goods by means of printed card butterflies, the body of which is a burr. These butterflies, when thrown, adhere to clothes and hair. Little imagination is needed to appreciate the large distances seeds may be carried by this means. Within recent years it was necessary to suppress such activities in this State but the adhering portion then consisted of the burr of burdock, another serious weed.

The war in the Pacific resulted in some unusual cargoes originally bound for other destinations reaching Australian ports and one of the strangest of these might have proved very costly. While other goods were being examined in a bond store at Fremantle by an officer of the Department of Agriculture some Bathurst burrs were noticed on the floor. A closer examination revealed that they had been spilt from a hole made by rats in a large container measuring some 4 feet by 4 feet by 5 feet. As the orientals attribute some medicinal properties to the burrs we can only assume that they had been consigned for that purpose. Hundreds of thousands of burrs likely to be distributed by rats and other means is not a happy thought even in a country where the weed is plentiful. Their value as a curative of human ills would have needed to compare favourably with that of penicillin to have saved them from immediate destruction in the incinerator.

Flood waters have proved a significant distributing agent particularly in the case of intermittent waterways. Plants become established in moist depressions which provide ideal conditions and then, following rains, the burrs are swept along the course of temporary rivers. This sequence of events is demonstrated on a large scale in New South Wales, but is also quite apparent on the flats and along the gullies in the vicinity of Kalgoorlie and Coolgardie.

Control.

When considering control, as with all weeds, early recognition followed by prompt action is the soundest advice that can be given. The importance of recognising a weed before it becomes thoroughly established cannot be over-

stressed and this applies particularly to Bathurst burr in the Agricultural areas of this State, for, with one exception, in no district have more than a few plants been located. When plants are found they should be dug carefully so that no burrs become detached and any burrs on the ground should also be gathered. The entire material should then be destroyed by burning. Where only one or two plants are found it is advisable to build the fire over the place from which they were removed. By this means any burrs left on the ground are unlikely to escape. The outcome of not carrying out such work in a thorough manner was clearly demonstrated during a recent inspection of an affected area. Two large plants some thirty inches in height and bearing possibly 100 burrs each had been grubbed only to be thrown into a dry open drain. This action would have served to spread rather than control the weed as the drains in this area run freely following rains. Even when all plants have been destroyed the site must be kept under observation for a number of years owing to the longevity of the seeds.

If there is any doubt concerning the identity of weeds, specimens should be forwarded to the Department of Agriculture for identification. Even in cases where serious weeds such as Bathurst burr are recognised by farmers, the Department is keen to have information concerning their distribution.

Further Notes on Mechanical Clearing.

CLEARING FOR FLAX COMMISSION AT BEELERUP WITH D.7 TRACTOR AND ANGLEDOZER.

Foreword by M. Cullity, Superintendent of Dairying.

Large bulldozers owned by the Public Works Department have been used for the past twelve months in the Mt. Barker-Narrikup area in clearing land for private farmers, and although only one machine has been in operation for the greater part of the year, over 3,000 acres have been treated preparatory to burning. The machines are controlled, operated and maintained by the Public Works Department while organisation of itineraries, collection of farmers, payments, etc., has been the responsibility of the Department of Agriculture. Information regarding the type of country cleared, the cost of bulldozing and ultimate cost of completing clearing and sowing of pastures is being collected and will be published in future issues of this journal. Reference has already been made ("Journal of Agriculture," Vol. XXII., No. 1, March 1945) to demonstrations carried out in the early part of 1944. Farmers' opinions on those trials suggested that the cost of knocking down was not more than one third of the cost of mullenising by hand. It was agreed that as the bulldozer removed the greater number of trees by their roots that a far better job was done than could be expected by hand. In some cases up to 95 per cent. of the trees were so treated.

On the basis of farmers' statements of estimated cost of clearing by hand it was estimated that the work carried out by one D7 machine in three months (with much waste time travelling) could not have been equalled by fifty men.

It will be appreciated therefore that the effectiveness of these machines should not be measured solely in terms of cost, but also by the speed with which the work is completed with the minimum of manpower.

The following notes prepared by officers of the Public Works Department on some clearing operations undertaken towards the end of 1944 are published in the hope that readers will gain from them some idea of the capabilities of these machines and their average operating costs in different types of country.

THE area cleared was 53 acres on Lot 53 adjacent to the Flax Mill at Beelerup.

The purpose of the clearing was to enable the flax authorities to leave ground on which to spread flax for dew retting, and for this purpose the trees knocked down by the bulldozer were later stacked by it so that a maximum area of cleared ground was left on which retting could be commenced immediately.

Both the surface and sub-soil were white sand and the land was timbered in two distinct zones which merged into each other where they met.

The lower sloping portion of the block was heavily timbered with banksia which thinned out towards the edge of the block. The only other vegetation on this zone was zamia palms and light brush with very little undergrowth. This zone merged into the upper flat portion which was typical light jarrah forest in which the merchantable timber had been cut out only recently, leaving the loppings spread about.

On the banksia zone, the entire vegetation, except for a few zamia palms, was able to be cleared, but in the jarrah zone the majority of the trees over 12 inches in diameter were too firmly rooted for the bulldozer to knock over. On a clay soil the bulldozer will knock over jarrah trees up to 18 inches in diameter.

A 'dozer in action.

If a push could be obtained higher up the tree than the 2ft. 6in. at present, the tractor would have sufficient power to push over much larger trees.* In this connection a bulldozer with an additional blade at a higher level is illustrated in "Pix," April 29th, 1944, issue, which, powered by an 80 h.p. tractor, can knock over trees up to 3 feet in diameter. The "treedozer," as it is termed, was made privately in Sydney.

If heavy clearing is to be done to any extent, a similar attachment would be of great value with the D.7 tractor and bulldozer.

In the banksia zone there was an average of 74 trees per acre, all being banksia which can be classified into the following diameters.

Size Diameter.	Under 6 in.	6 in. to 9 in.	9 in. to 12 in.	12 in. to 15 in.	15 in. to 18 in.	18 in. to 24 in.	24 in. to 30 in.
Banksia per acre	16	16	21	11	5	3	2

In the jarrah zone the average classification per acre was as follows:—

Diameter.	Under 6in.	6 in. to 9 in.	9 in. to 12 in.	12 in. to 15 in.	15 in. to 36 in.
Jarrah	11	10	5	3	...
Banksia	5	6	3	4	...
Other	10	3	2	3	...
Blackboy	55	...	...	...	...
Jarrah left standing ...	...	...	...	3	12

The clearing consisted of two distinct operations, the first of which was to go over the area with the bulldozer and knock over everything it was able to, the second of which was to push everything knocked over into heaps or rows. It was not possible to combine these two operations as the timber was too large and unwieldly to rill off the blade when falling it.

(1) In this operation the tractor driver worked systematically up and down the area and knocked over all the trees and scrub he could. The area he covered per day varied very little in the different classes of timber and a daily average struck after he had worked a few days in the banksia area was maintained fairly closely over the whole block. The area fallen was 53 acres in 65 hours worked on seven days or 0.8 acres per hour.

(2) In the stacking operation the bulldozer was driven at right-angles to the direction in which the falling was done. The driver was able to carry the material 1½ to 2½ chains, thus making lanes 3 to 5 chains wide, depending on the density of the timber. In the jarrah areas the stacks were not in continuous rows, as was done in the banksia area, but were arranged around the standing timber to give the greatest clear ground area. The stacking operations took 131½ hours worked on 14 days or 0.4 acres per hour.

The tractor was driven from Boyup Brook to Beelerup under its own power on a gravel road. The rate of travel was approximately 2½ miles per hour. The time allocated against travelling was 23½ hours.

* A blade capable of rising 7 feet from ground level has since been fitted.—Ed.

Servicing.—The time spent on fuelling, oiling, greasing and checking over the machine was an average of 1¼ hours each day worked, with an additional total of 14 hours worked during week-ends, making a total of 40½ hours.

The total time worked, including travelling from Boyup to Beelerup, and servicing, was 260½ hours, of which—

185 hours was at single time,
44 hours at time and one-half,
31½ hours at double time.

	£ s. d.	£ s. d.
Costs:		
Drivers' Wages (including pay roll tax and tent allowance)		50 16 7
Hire of bulldozer and tractor (1 month less 1 day)		83 6 8
Fuel and oil		52 13 1
Sundry Costs:		
Welding repair	0 7 6	
Fares and travelling allowance	6 5 0	
Cost of transporting material and visiting the clearing	7 16 8	
		14 9 2
Workers' Compensation		1 13 7
Total cost		£202 19 1

Included in this cost is the following cost of moving the tractor from Boyup to Beelerup:—

Wages:	£ s. d.
21½ hours @ single time; 2 hours @ 1½ time—24½ hours @ £6 9s. 8d. week	3 12 3
50 gallons of distillate @ 1/9	4 7 6
Oil, say, £1	1 0 0
Hire 2½ days @ £2 12s. 6d.	6 11 3
Transport of camp, etc.	4 2 0
	£19 13 0

Cost per acre:

	£ s. d.
(a) Falling	1 5 6
(b) Stacking	2 11 1
Falling and Stacking	£3 16 7

HARVEY DISTRICT.

The object of clearing in this district was to open up additional potato land.

The D.7 Caterpillar Tractor with Bulldozer attachments was stationed in this area for four months during which time there were 82½ working days or

650 effective working hours. Three hundred and seventy-eight acres were cleared. Farmers were anxious for a maximum area of trees knocked down, so that apart from one eight-acre plot, no time was spent in stacking.

Practically all trees knocked over were up-rooted. Little trouble was experienced with breaking off at ground level.

Time worked effectively.	Hours idle due to bogging.	Days idle due to breakages and repairs.	Hours spent travelling.		Hours spent servicing.
			Between properties.	To and from district.	
82½ days @ 650 hours	26 hours	23½ days	24	18	93

Gross working days in the district: 30/6/44 to 7/11/44, including days travelling to and from the district = 112 days.

Of the time idle due to breakages and repairs, 13 days were lost when the unit first arrived in the district due to breaking the sump. This necessitated parts being sent to Perth. Hire charges were waived for this period and other charges were not debited to the clearing authority.

Five days were lost due to broken winch housing—an exceptional delay due to bad organisation.

Three days were lost due to eight studs shearing off the track frame.

These major stops represent 21 of the total 23½ days idle due to breakages and repairs.

Acres Cleared.	Total Cost.	Cost. per Acre	Cost per effective day worked.	Cost per Hour.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
378	807 10 5	2 2 6	9 16 0	1 4 10

The cost per acre varied considerably for different types of clearing, as can be seen from the following figures:—

	No. of Acres.	No. of Hours.	Cost.	Cost per Acre.
			£ s. d.	£ s. d.
State Farm	60	110	130 18 2	2 4 0
Dempster	90	186	223 0 6	2 10 0
B. Lofthouse	45	112	133 15 6	3 0 0
Barnes	75	87	103 15 8	1 8 0
S. Fry	60*	99	118 3 11	2 0 0
V. Abbott	5†	21	25 1 3	5 0 0
Gibbs Bros.	5	18	21 9 0	4 4 0
A. Barnes	38	43	51 6 5	1 7 0
Total	378	676	807 10 5	...

* Plus Road † Plus Drain.

Property.	Labour.	Freight and other Charges.	Material.	Plant Hire.	Totals.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
State Farm	38 12 0	2 7 2	33 10 3	56 8 9	130 18 2
Dempster	66 8 3	4 14 4	56 12 10	95 5 1	223 0 6
B. Lofthouse	39 14 9	2 9 3	34 2 0	57 9 6	133 15 6
Barnes	30 17 0	1 16 8	26 9 0	44 13 0	103 15 8
S. Fry	35 2 6	2 2 5	30 2 6	50 16 6	118 3 11
V. Abbott	7 8 9	11 3	6 5 9	10 15 6	25 1 3
Gibbs Bros.	6 7 6	9 9	5 7 0	9 4 9	21 9 0
A. Barnes	15 5 5	15 7	13 4 1	22 1 4	51 6 5
Total	239 16 2	15 6 5	205 13 5	346 14 5	807 10 5

This analysis reveals the following approximate figures:—

Labour costs: £3 per day.

Material: £2 10s. per day.

Plant Hire: £4 per day.

STATE FARM—£2 4s. per acre.

Situated at Wokalup in the hills. Sixty acres in all were cleared, made up of two areas—42 acres and 18 acres.

The first and larger area was mostly a dense growth of blackboys averaging approximately 6ft. apart of 120 per sq. chain, varying in size from a few inches high to 2ft. Red gum saplings up to 6in. in diameter 10 per acre sparsely scattered over the area. Approximately 50 per cent. of the blackboys were missed due to the roughness and slope of the country. Rock outcrops were plentiful. Small blackboys with leaves only showing above the ground were not unearthed.

The second area of 18 acres was much more densely timbered. Twelve acres of red gum and jarrah saplings up to 6in. diameter averaged 10 per square chain. The remaining six acres supported a thicket of red gum and jarrah saplings with an intensity of 20 per sq. chain. Blackboys were numerous over the area. One large dead tree per acre, over 18in. in diameter, was knocked down. Hillside showed seepage patches.

DEMPSTER—£2 10s. per acre.

Fifty-three acres part heavy; 27 acres light, but difficult travelling.

Situated south-east of Wokalup on undulating hill country—90 acres were light white gum country up to 18in. diameter, interspersed with jarrah and red gum and a light scrub undergrowth. From 6in. to 18in. in diameter—15 per square chain. Blackboys were scattered throughout the area. Four acres were pasture paddocks with rung trees one per sq. chain up to 2ft. 6in. diameter. The remaining 27 acres was hilly and stony with irregular rock outcrops. Parts were very steep. The vegetation was a sparse scattering of suckers up to 9in. diameter. Very little scrub undergrowth. Occasional big trees up to 18in. diameter and big dead trees knocked over.

B. LOFTHOUSE—£3 per acre.

Small timber, but thick. This area was good potato land. Forty-five acres in area. Situated in the hill country south-east of Wokalup. Fifteen acres were evenly timbered gently sloping hillside with jarrah and red gum saplings

up to 9in. diameter, mostly under 6in. diameter, averaging 20 per sq. chain. There were no big green trees but odd dead trees were knocked over. Blackboys occurred in dense patches and were mostly removed.

The remaining 30 acres showed a variety of timbering. Eight acres was a white gum flat with trees up to 9in. diameter.

Seven acres of lightly timbered jarrah and red gum re-growth with practically no undergrowth.

Fifteen acres on the sloping sides of a watercourse were heavily timbered with red gum with a sprinkling of jarrah 9in. to 12in. in diameter—a light scrub undergrowth.

BARNES—£1 8s. per acre.

Dense sapling country. This property situated on the foothills and extending into the hills south-east of Wokalup, comprises 75 acres. The surface was stony with no sign of seepage patches.

Fifteen acres formed pasture paddocks with a re-growth of red gum saplings up to 9in. diameter. This was on gently sloping ground. Timber intensity was 50 saplings per sq. chain. The remaining 60 acres on steeper hillside consisted of young red gums up to 6in. diameter, 30 per sq. chain, and young blackboys up to 6in. in height, 100 per sq. chain—50 per cent. of these were unearthed. Those showing leaves only above the ground were untouched.

Occasional dead trees up to 30in. diameter were knocked down.

Six chains of roadway were formed to provide access to the new clearing.

Trees on an 8-acre area on the thicker timbered hillside were stacked in rows.

S. FRY—£2 per acre.

Twenty acres very light, 29 acres much dead timber. Difficult country. Eleven acres partly heavy saplings.

This property was in the hill country east of Wokalup. Clearing was done over an area of 60 acres.

Twenty acres comprised pasture paddocks at the foot of the hills and work here entailed knocking over dead trees averaging 2ft. diameter occurring approximately two per acre.

Twenty-nine acres on steeply sloping country in the hills was cleared of dead trees. These occurred thickly over the area, five per sq. chain, from 6in. to 12in. in diameter, with bigger trees up to 2ft. diameter less frequently. No green timber was touched.

The remaining 11 acres was mostly green timber—jarrah and red gum re-growth occurring 20 per sq. chain, from 4in. to 9in. in diameter. Occasional dead trees were knocked over. Blackboys were on the area but not in dense patches. Those of any size were removed.

Ten chains of access road were formed through a rough steeply sloping ridge.

V. ABBOTT—£5 per acre.

This area of five acres was on the plains south-west of Wokalup. The soil was sandy. The tree growth was a dense re-growth of jarrah and red gum saplings up to 9in. in diameter, 15 per sq. chain with three per sq. chain up to 12in. diameter. Large dead trees from 2ft. to 4ft. in diameter occurring one per sq. chain, were knocked over, but large green trees up to 4ft. diameter were left.

A number of the saplings grew from old tree stumps and in most cases these could not be removed. This factor, combined with the poor traction in the sandy soil, made progress slow.

One acre of dense ti-tree and paperbark swamp was cleared and a drain approximately five chains long was formed through the clearing. This drain was 12ft. wide and a foot to 18in. deep.

GIBBS BROS.—£4 4s. per acre.

Situated two miles east of Harvey in the hills. A total area of five acres was cleared. The vegetation was dense peppermint with scattered red gum saplings 10 per square chain. Large dead red gums, eight per acre up to 3ft. diameter, were knocked down. There was a bracken and heavy grass mat undergrowth. A creek runs through the area but peppermints immediately lining the water were not touched. The clearing was done on gently sloping hillside. Good loam for potato growing.

A. BARNES—£1 7s. per acre.

Situated six miles east of Harvey in the hills. A total of 38 acres was cleared on this property. Thirty-two acres was of jarrah and red gum with occasional wandoo. Ten saplings up to 6in. diameter per sq. chain, four from 6in. to 15in. diameter per sq. chain, one over 15in. diameter per sq. chain, was left as it was considered uneconomical to spend time on these odd trees.

Dead trees up to 2ft. diameter occurring two per acre were knocked over. The work was on gently sloping laterite hills—good potato land. The other six acres was more densely timbered. Twelve trees from 6in. to 15in. per sq. chain. Trees over 15in. diameter, four per sq. chain, were not touched. Three hours was spent on firebreaks on this property.

Flock Establishment and Improvement.

By

W. L. McGARRY, Sheep and Wool Adviser.

IT is generally agreed that the present high prices ruling for Merino wool will not last indefinitely. In view of this and while prices are very profitable, an admirable opportunity exists for growers to take steps leading to flock improvement. Improved returns per head from better sheep will enable woolgrowers to better withstand the inevitable decline in wool prices.

Production Costs.

Production costs are of paramount importance in wool production particularly when lower prices rule and in the main the most feasible way in which the grower can reduce his production costs is by increasing the *quantity* and *quality* of wool cut per head of sheep—or in other words by increasing the monetary returns per head of sheep run. Producing cheaper wool means producing more and better wool per sheep.

Quantity and Quality.

The aim in woolgrowing should be to produce as great a quantity of good quality wool per sheep as possible. Quality is emphasised because in Merino wool a premium is paid for quality and for this reason the desirability of retaining quality is very important and should not be overlooked when striving for quantity.

Feeding.

The amount of wool cut per sheep is governed by two factors. They are nutrition (or feed) and breeding (or inheritance). Of the two there is no doubt that nutrition plays the biggest part in the amount of wool cut per sheep. Unless a sheep is on a good level of nutrition from the time it is born it is unable to produce the maximum amount of wool of which it is genetically capable—or in other words it is unable to fully express in wool production its inheritance for this factor. Good nutrition results in the development of more wool producing follicles during the growth of the sheep, which in turn leads to greater wool density or in other words more fibres per square inch of skin on the sheep. Good nutrition will also make a bigger sheep with a larger skin area on which to grow wool. The more wool bearing skin on a sheep the better (up to a point) as it has been found that about 90 per cent. of the skin area on a sheep is bare. Thicker and longer wool fibres are grown by the sheep when the nutritional conditions are good and if the millions of fibres that go to make up a fleece are thick and long instead of thin and short then the fleece must be heavier, provided of course, the wool density is about the same.

Effects of Nutrition.
Two ewes—same age—same sire. Left: well nourished, body weight 119 lbs. Right: poorly nourished, body weight 54 lbs.

Breeding.

It is often remarked that the term "quality" in Merino wool is rather a vague term and it appears desirable to define "quality"—that is thinking in terms of "good quality" wool and not referring to the count or fibre thickness.

A quality wool can be described as a wool possessing to a high degree all those characteristics which wool buyers and wool manufacturers desire and pay high premiums for.

These characteristics are:—

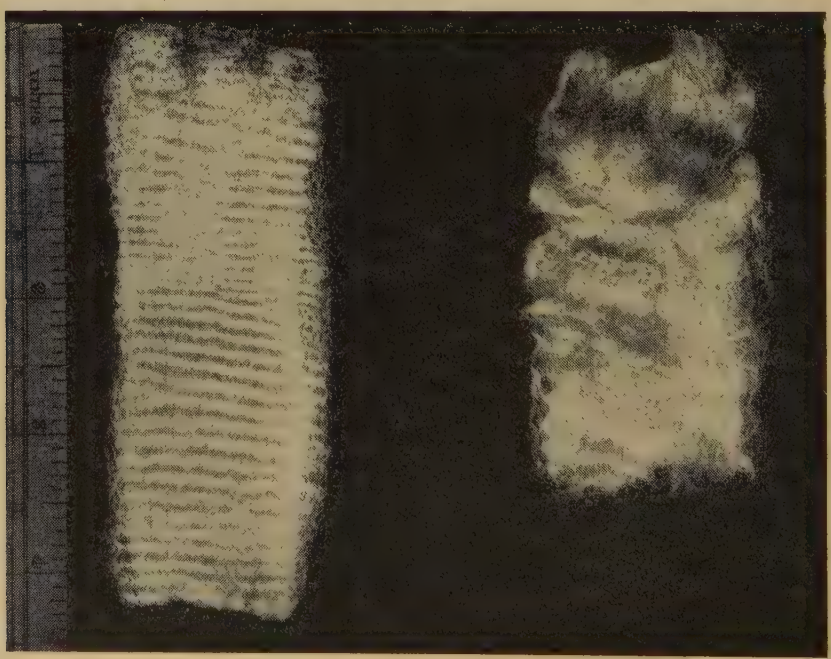
(1) Good staple length.
(2) Correct staple length for fibre thickness.
(3) Soundness throughout the whole staple length.
(4) Robust or thick staple.
(5) Pronounced, regular and even crimp.
(6) Good square tip free from hairyness and fluffiness.
(7) Free and even fibre growth throughout the staple.
(8) Density.
(9) Softness.
(10) Elasticity.
(11) Colour.

Although nutrition (feed) plays a part in some of these characteristics the main role of nutrition is to produce *quantity* and reliance must be placed more on *breeding* rather than *feeding* if we are to establish and retain quality in our wool.

In woolgrowing feeding and breeding must go together to get the optimum returns. Breeding without feeding is senseless and feeding without breeding is only going half way because a sheep of poor type costs as much to feed and care for as a good one and a good type will convert feed into wool and meat much more profitably than a poor type.

Sheep Type.

When establishing a Merino flock it is advisable to give careful thought in deciding the type which will be most suitable for the conditions under which the sheep are to be run.



Strong Wool Type.
Left: Good quality. Right: Poor quality

Our agricultural areas are suitable for the production of both medium and strong wool and in the pasture or better feed areas it is advisable to remember the important influence of good nutrition and climate on fibre thickness (count) when deciding on wool type because the production of over strong and "doggy" wool is undesirable and unprofitable.

Generally the quality within the type is more important than the type itself, i.e., a good medium wool flock is better than a poor strong wool flock and vice versa.

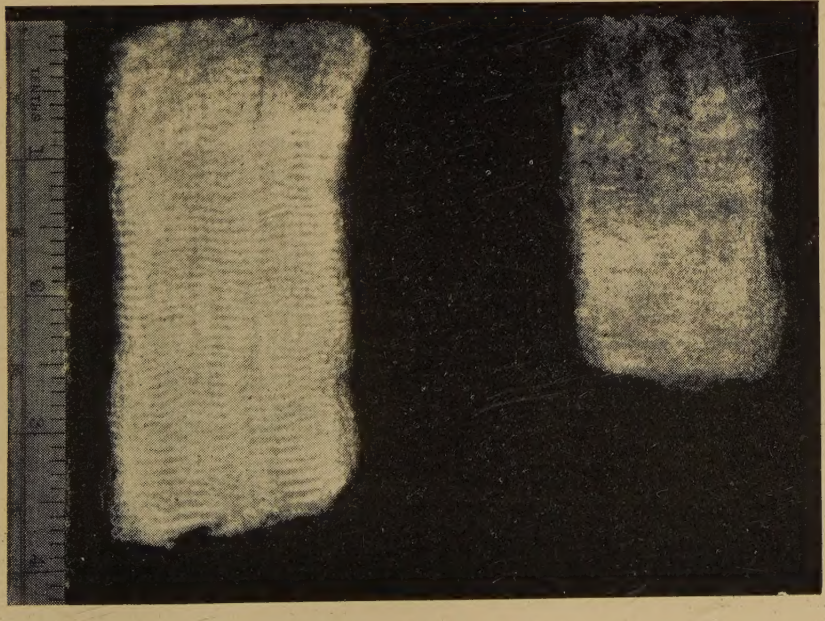
Foundation Ewes.

It is advisable to purchase these from a reputable breeder known to have good sheep. The choice generally lies between young ewes (which are usually sold for some fault) or cast for age ewes. It is generally agreed that the C.F.A. ewes will make the safer foundation stock. Proof of their merit lies in the fact that they have been kept in the flock a number of years and would be superior to the average of the breeding flock.

They would also, with proper treatment, give a better lambing percentage than the young ewes.

It must not be forgotten, however, that their fleeces will be light and that their progeny, in the main, will not be as good as themselves and will tend to revert down to the average of the flock from which the mothers came.

The young ewes (assuming they have faults but are not outright culls) will have a longer wool producing life in front of them, and though somewhat inferior themselves would have progeny which would tend to revert up to the average of the young ewes kept because of merit and as a result would produce many useful sheep.



Medium Wool Type.
Left: Good quality. Right: Poor quality.

When considering the purchase of foundation ewes it is a definite advantage to inspect the sheep in the wool beforehand if possible and also ascertain when they were shorn. This inspection will reveal their wool type and cutting possibilities which is not possible off shears.

Culling.

An annual culling or classing of maiden ewes just prior to shearing is a necessary part of flock improvement. The main benefit of an annual culling is an increase in *immediate* returns. It is advisable to cull with a view to higher immediate returns and then rely on a wise selection of rams for the future improvement of the flock. The sheep to be culled will be those showing serious defects, poor constitutioned and off type sheep and those lacking in wool quantity and quality. Serious defects are obvious at a glance and would include slab-sides, bad hocks and feet, badly undershot or overshot jaws, woolly faces, etc.

An elevated classing race is an advantage but in practice the average farmer's flock can be classed quite satisfactorily in the drafting and branding races. If the sheep are put through the drafting race first the obvious culls can be taken out with a minimum of labour as they come down the race. It will be necessary to inspect the remainder closely in the branding or classing race where the movement of the sheep is restricted.

When the classing is completed the flock should be drafted into three yards—outright culls, culls, and keepers. It is then advisable to walk slowly among the sheep and rectify any mistakes made. Always ear mark the culls on the spot before they leave the yard with the prescribed cull mark, i.e., a punch hole in the opposite ear to that bearing the registered ear mark.

It is a waste of time and money to cull a flock and not dispose of the culls.

Selection of Rams.

The ram plays a much bigger part in the improvement of the flock than the ewe and for this reason careful selection is necessary when purchasing sires. Always avoid cheap and inferior sires.

Whenever possible it is advisable for growers to select their own rams, because they, by virtue of their close association with the flock, should be best qualified to select suitable rams. If in doubt growers should seek the opinion of those who are experienced and qualified to advise and who have had the opportunity of inspecting the flock.

Rams should not be selected for fancy points of imagined importance to the exclusion of commercial characteristics which should be the main consideration. It is obvious that something must be "given away" in rams of the 10-20 guinea grade, and it is important not to give away valuable commercial characteristics for points of secondary importance.

Rams should be selected with a view to producing good constitutioned, compact sheep possessing warp (good length) wool of good quality which will process into good weights of *scoured* product.

Research work has shown that the extensive use of progeny tested sires would result in spectacular flock improvement in a very short time. However, owing to many difficulties, indications are that it will be some time before commercial growers can purchase progeny tested rams or even rams sired by progeny tested rams in numbers. The selection of rams at present is still on a basis of pheno-type, i.e., appearance, and in view of this the following principles will prove useful as a guide when selecting:—

1. It is advisable to select rams from those studs where the standard of the sheep in the stud is uniformly high and even. Flock improvement will be more certain if rams are secured from studs of this type than where sires are secured from studs which have a *few* outstanding sheep, but where the *average* quality of the sheep is not high and even.

2. Select from those studs whose rams by experience *retain* or *improve* their quality under the conditions where they are used.

3. Keep to the one blood, and if possible, to the one breeder.

4. Select rams with the type of wool most suited to the country where they are to breed.

5. Rams should be somewhat stronger (not over strong) in the wool than the flock count (fibre thickness) which is desired. Definite and even crimp in the fleece, a thick upright staple of good length and good tip are desirable.

6. Soundness in feet, mouth, reproductive organs, constitution and freedom from defects generally transmitted are main considerations. Do not be carried away by "pretty" wool to the exclusion of essentials.

A beneficial breeding practice, particularly in medium wool flocks, is to grade the breeders and rams as soon as they are shorn according to their development and mark or brand them accordingly. The development is masked to a certain extent when the sheep are in the wool, but can be readily seen off shears.

This grading can be done practically all through the drafting race and most flocks would average about half each of the two types, i.e., "plain" and "developed" to varying degrees. If this is done, then at mating join the more developed rams with the plainer bodied ewes and the more developed ewes with the plainer bodied rams. This procedure will tend to improve the conformation and cut per head of the progeny and lead to greater uniformity.

ERRATA.

VOL. XXIV., No. 1, MARCH, 1947.

Page 33, foot of Table III:—*To* "W.A. = Water absorption" *add* "on a 13.5 per cent. moisture basis."

Page 34, section 3, second paragraph, line 5:—*For* "top of the grain falls below the level of the mid-point of the graph" *read* "top of the graph falls below the level of the mid-point of the graph."

Page 36, Table IV, under heading "Variety and Source":—In each instance after "Specific Protein strength from" *insert* "(a)" before "strength figure" and "(b)" before "Pelshenke time."

Paragraph one, line six:—*For* "either figure or the Pelshenke time" *insert* "either strength figure or Peleshenke time."

Page 69, paragraph two:—*Delete* "MERREDIN, Mr. E. R. Watson, B.Sc., (Agric.)."